ADVANCED PEST CONTROL

CONTINUING EDUCATION
PROFESSIONAL DEVELOPMENT COURSE

Light star	EFFECTIVE CONTROL
Dark star	PARTIALLY EFFECTIVE CONTROL
Grey star	WILL EAT ANYTHING IT CAN FIND
Diamond	BACTERIA

HARMFUL INSECTS

BENEFICIAL INSECTS

	SPIDER MITES	FLAT MITES	APHIDS	THRIPS	WHITE FLIES	FUNGUS GNATS	GNAT LARVAE	MEALY BUGS	SCALES	BEATLES	CATERPILLARS
LADYBUG *(Hippodamia convergens)*	Effective		Effective	Effective	Effective			Partially effective	Effective		
PIRATE BUG *(Orius insidiosis)*	Effective		Effective	Effective	Effective			Partially effective	Effective		
PRAYING MANTIS *(Tenodera sinensis)*	Will eat anything	Will eat anything	Will eat anything	Will eat anything	Will eat anything	Will eat anything	Will eat anything	Will eat anything	Will eat anything	Will eat anything	Will eat anything
GREEN LACEWING *(Chrysopa rufilbris)*		Effective	Effective	Effective	Effective			Partially effective	Effective		
SPIDER MITE PREDATORS *(Phytoseiulus persimilis, Neoseiulus californicus, Mesoseiulus longipipes)*	Effective										
SPIDER MITE DESTROYERS *(Stethorus punctilum)*	Effective										
WHITEFLY PARASITE *(Encarsia formosa)*					Effective						
APHID PREDATOR *(Aphidoletes aphidimyza)*		Effective									
APHID PARASITES *(Aphidoletes matricariae)*		Effective									
PREDATORY NEMATODES				Effective		Effective	Effective				Effective
THRIP PREDATOR MITES *(Amblyseius cucumeris)*	Effective			Effective							
FUNGUS GNAT PREDATORS *(Hypoaspis)*	Effective			Partially effective		Effective	Effective				
MEALYBUG DESTROYER *(Cryptoaemus montrouzieri)*			Effective					Effective	Effective		
◆ SPINOSAD *(Saccharopolyspora spinosa)*	Partially effective		Effective							Effective	Effective
◆ BACILLUS THURINGIENSIS						Effective	Effective				

BENEFICIAL INSECT IPM (Integrated Pest Management) CHART

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Printing and Saving Instructions

The best thing to do is to download this pdf document to your computer desktop and open it with Adobe Acrobat DC reader.

Adobe Acrobat DC reader is a free computer software program and you can find it at Adode Acrobat's website.

You can complete the course by viewing the course materials on your computer or you can print it out. Once you've paid for the course, we'll give you permission to print this document.

Printing Instructions: If you are going to print this document, this document is designed to be printed double-sided or duplexed but can be single-sided.

This course booklet does not have the assignment. Please visit our website and download the assignment also.

Internet Link to Assignment…
http://www.abctlc.com/downloads/PDF/AdvancedPestASS.pdf

State Approval Listing Link, check to see if your State accepts or has pre-approved this course. Not all States are listed. Not all courses are listed.

Call your State agency to see if the course is accepted.

State Approval Listing URL…
http://www.abctlc.com/downloads/PDF/CEU%20State%20Approvals.pdf

You can obtain a printed version from TLC for an additional $199.95 plus shipping charges.

All downloads are electronically tracked and monitored for security purposes.

Important Information about this Manual (Disclaimer notice)

This CEU course manual has been prepared to educate pesticide applicators and operators in general safety awareness of dealing with the often-complex and various pesticide treatment devices, methods, and applications.

This manual covers general laws, regulations, required procedures, and accepted policies relating to the use of pesticides. It should be noted, however, that the regulation of pesticides and hazardous materials is an ongoing process and subject to change over time. For this reason, a list of resources is provided to assist in obtaining the most up-to-date information on various subjects.

This manual is not a guidance document for applicators or operators who are involved with pesticides. It is not designed to meet the requirements of the United States Environmental Protection Agency or your local State environmental protection agency or health department.

This CEU course manual provides general pesticide safety awareness and should not be used as a basis for pesticide treatment method/device guidance. This document is not a detailed pesticide information resource or a source or remedy for poison control.

Technical Learning College or Technical Learning Consultants, Inc. make no warranty, guarantee or representation as to the absolute correctness or appropriateness of the information in this manual and assumes no responsibility in connection with the implementation of this information.

It cannot be assumed that this manual contains all measures and concepts required for specific conditions or circumstances. This document is to be used solely for educational purposes only and is not considered a legal document.

Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in the original labeled containers in a locked cabinet or shed, away from food or feeds, and out of the reach of children, unauthorized persons, pets, and livestock.

Confine chemicals to the property being treated. Avoid drift onto neighboring properties, especially gardens containing fruits and/or vegetables.

Dispose of empty containers carefully. Follow label instructions for disposal. Never reuse containers. Make sure empty containers are not accessible to children or animals.

Never dispose of containers where they may contaminate water supplies or natural waterways.

Do not pour down sink or toilet. Consult your county agricultural commissioner for correct ways of disposing of excess pesticides. Never burn pesticide containers.

Individuals who are responsible for pesticide storage, mixing, and application should obtain and comply with the most recent federal, state, and local regulations relevant to these sites and are urged to consult with the EPA and other appropriate federal, state, and local agencies.

Precept-Based Training Course

This training course is based upon a form of induction training, made of topical and technical precepts. The training topics are made up of “micro-content” or “precepts”– or small chunks of information that can be easily digested. These bite-size pieces of technical information are considered to be one of the most effective ways of teaching people new information because it helps the mind retain knowledge easier.

Micro-learning or precept-based training doesn’t rely on the student to process a large amount of information before breaking it down. Our method includes short modules with clearly defined learning goals for each section. This method allows a student to hone in on a particular skill, then given the opportunity to exhibit their knowledge in the final assessment.

Some States and many employers require the final exam to be proctored.

Do not solely depend on TLC’s Approval list for it may be outdated.

Most of our students prefer to do the assignment in Word and e-mail or fax the assignment back to us. We also teach this course in a conventional hands-on class. Call us and schedule a class today.

Responsibility

This course contains EPA’s WPS federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA’s or OSHA’s regulations. Check with your state environmental/pesticide agency for more information. You are solely responsible in ensuring that you abide with your jurisdiction or agency’s rules and regulations.

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This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these are frequently changed. Check with your state environmental/pesticide agency for more information.

READ THE LABEL!

Technical Learning College's Scope and Function

Welcome to the Program,

Technical Learning College (TLC) offers affordable continuing education for today's working professionals who need to maintain licenses or certifications. TLC holds several different governmental agency approvals for granting of continuing education credit.

TLC's delivery method of continuing education can include traditional types of classroom lectures and distance-based courses or independent study. TLC's distance-based or independent study courses are offered in a print - based distance educational format. We will beat any other training competitor's price for the same CEU material or classroom training.

Our courses are designed to be flexible and for you to finish the material at your convenience. Students can receive course materials through the mail or electronically. The CEU course or e-manual will contain all your lessons, activities and instruction to obtain the assignments. All of TLC's CEU courses allow students to submit assignments using e-mail or fax, or by postal mail. (See the course description for more information.)

Students have direct contact with their instructor—primarily by e-mail or telephone. TLC's CEU courses may use such technologies as the World Wide Web, e-mail, CD-ROMs, videotapes and hard copies. (See the course description.) Make sure you have access to the necessary equipment before enrolling; i.e., printer, Microsoft Word and/or Adobe Acrobat Reader. Some courses may require proctored closed-book exams, depending upon your state or employer requirements.

Flexible Learning
At TLC, there are no scheduled online sessions or passwords you need contend with, nor are you required to participate in learning teams or groups designed for the "typical" younger campus - based student. You will work at your own pace, completing assignments in time frames that work best for you. TLC's method of flexible individualized instruction is designed to provide each student the guidance and support needed for successful course completion.

Course Structure
TLC's online courses combine the best of online delivery and traditional university textbooks. You can easily find the course syllabus, course content, assignments, and the post-exam (Assignment). This student-friendly course design allows you the most flexibility in choosing when and where you will study.

Classroom of One
TLC offers you the best of both worlds. You learn on your own terms, on your own time, but you are never on your own. Once enrolled, you will be assigned a personal Student Service Representative who works with you on an individualized basis throughout your program of study. Course specific faculty members (S.M.E.) are assigned at the beginning of each course providing the academic support you need to successfully complete each course. Please call or email us for assistance.

TLC Continuing Education Course Material Development

Technical Learning College (TLC's) continuing education course material development was based upon several factors; extensive academic research, advice from subject matter experts, data analysis, task analysis and training needs assessment process information gathered from other states.

We welcome you to complete the assignment in Word. You can easily find the assignment at www.abctlc.com.

Once complete, just simply fax or e-mail the answer key along with the registration page to us and allow two weeks for grading. Once we grade it, we will mail a certificate of completion to you. Call us if you need any help.

COURSE DESCRIPTION

ADVANCED PEST CONTROL CEU TRAINING COURSE

This course covers difficult to control insects (Africanized Bees, Mosquitoes, Termites, Bed Bugs, Ticks and Bark Beetles), advanced pest control techniques, (Rodding and Injecting) pesticide safety training procedures and review the federal pesticide rule (WPS). It will also cover various types of pesticides, application methods, insect identification and control methods, and pesticide spill clean-up procedures. This course is general in nature and not state specific. No other materials are needed for this course.

Course Objective
To provide educational resource for continuing education requirement in effective and safe pesticide application, insect identification, control/treatment methods and various pesticide safety regulations, personal protective equipment requirements and clean-up procedures.

Course Registration and Support
TLC offers complete registration and support services for all correspondence courses via e-mail, Web site, telephone, fax, and mail. TLC will attempt to provide immediate, prompt service. When a student registers for a distance or correspondence course, he/she is assigned a “start date” and an “end date.” It is the student's responsibility to note dates for assignments and keep up with the course work. If a student falls behind, he/she must contact TLC and request an end date extension in order to complete the course. It is the prerogative of TLC to decide whether or not to grant the request. Students have 90 days from receipt of this manual to complete the assignments in order to receive their continuing education units (CEUs) or professional development hours (PDHs). A score of 70% or better is necessary to pass this course. If students need any assistance, they should e-mail or call TLC with their concerns. In the interest of privacy, students’ social security numbers are not used for tracking. Instead, a unique, alternate number is assigned to each student.

Final Examination for Credit
Opportunity to pass the final comprehensive examination is limited to three attempts per course enrollment.

Instructions for Written Assignments
The Advanced Pest Control training course uses multiple choice and true/false questions. Answers may be written in this manual or typed out on a separate answer sheet. TLC prefers that students type out and e-mail their answer sheets to info@tlch2o.com, but they may be faxed to (928) 468-0675.

Grading Criteria
TLC will offer the student either pass/fail or a standard letter grading assignment. If TLC is not notified, you will only receive a pass/fail notice. For security purposes, please fax or e-mail a copy of your driver’s license and always call us to confirm we’ve received your assignment and to confirm your identity. TLC offers students the option of either pass/fail or assignment of a standard letter grade. If a standard letter grade is not requested, a pass/fail notice will be issued.

Final course grades are based on the total number of possible points. The grading scale is administered equally to all students in the course. Do not expect to receive a grade higher than that merited by your total points. No point adjustments will be made for class participation or other subjective factors.

If TLC is not notified, you will only receive a pass/fail notice. In order to pass your final assignment, you are required to obtain a minimum score of 80% on your assignment.

Security and Integrity
We expect every student to produce his/her original, independent work. Lesson sheets and final exams are not returned to the students, to discourage sharing of answers. If any fraud or deceit is discovered, the student will forfeit all fees, and the appropriate agency will be notified. Any student whose work indicates a violation of the Academic Misconduct Policy (cheating and/or plagiarism) can expect penalties as specified in the Student Handbook, which is available through Student Services; contact them at (928) 468-0665.

Environmental Terms, Abbreviations, and Acronyms
TLC provides a glossary in the rear of this manual that defines, in non-technical language, commonly used environmental terms appearing in publications and materials, as well as abbreviations and acronyms used throughout the EPA and other governmental agencies.

Record Keeping and Reporting Practices
TLC keeps all student records for a minimum of five years.
It is the student's responsibility to give the completion certificate to the appropriate agencies.

Required Texts
This course comes complete and does not require any other materials.

Feedback Mechanism (Examination Procedures)
A feedback form is included in the front of each study packet.

ADA Compliance
TLC will make reasonable accommodations for persons with documented disabilities. Students should notify TLC and their instructors of any special needs. Course content may vary from this outline to meet the needs of these particular students.

Note to Students
Keep a copy of everything that you submit! If your work is lost, you can submit your copy for grading. If you do not receive your certificate of completion or other results within two to three weeks after submitting it, please contact your instructor.

Important Information about this Manual
This manual has been prepared to educate pesticide applicators and operators in general safety awareness of dealing with the often complex and various pesticide treatment devices, methods, and applications.

This manual covers general laws, regulations, required procedures, and accepted policies relating to the use of pesticides. It should be noted, however, that the regulation of pesticides and hazardous materials is an ongoing process and subject to change over time. For this reason, a list of resources is provided to assist in obtaining the most up-to-date information on various subjects.

This manual is a not a guidance document for applicators or operators who are involved with pesticides. It is not designed to meet the requirements of the United States Environmental Protection Agency or any local state environmental protection agency or health department.

This course manual provides general pesticide safety awareness and should not be used as a basis for pesticide treatment method/device guidance. This document is not a detailed pesticide manual or a source or remedy for poison control.

Educational Mission

The educational mission of TLC is:

To provide TLC students with comprehensive and ongoing training in the theory and skills needed for the pesticide application field,

To provide TLC students with opportunities to understand and apply the theory and skills needed for pesticide application certification,

To provide opportunities for TLC students *to* learn and practice pesticide application skills with members of the community for the purpose of sharing diverse perspectives and experience,

To provide a forum in which students can exchange experiences and ideas related to pesticide application education,

To provide a forum for the collection and dissemination of current information related to pesticide application education, and

To maintain an environment that nurtures academic and personal growth.

GROUP OF PESTICIDES	PURPOSE AND USES OF THESE PESTICIDE GROUPS
ALGAECIDES	USED TO KILL AND PREVENT GROWTH OF ALGAE (i.e: Common Use In Swimming Pools)
ANTIMICROBIALS	USED TO KILL MICROORGANISMS THAT PRODUCE DISEASES
ATTRACTANTS	THIS PESTICIDE IS USED TO ATTRACT SPECIFIC PESTS USING NATURAL INSECT CHEMICALS CALLED PHEROMONES TO CONFUSE INSECTS MATING BEHAVIOUR
AVICIDES	USED TO CONTROL PEST BIRDS
BIOPESTICIDES	THESE ARE NATURALLY OCCURING SUBSTANCES THAT HAVE PESTICIDAL PROPERTIES
DEFOLIANTS	THIS PESTICIDE GROUP CAUSES FOLIAGE TO DROP FROM A PLANT, TYPICALLY USED IN THE HARVESTING PROCESS
DESICCANTS	AIDS IN THE DRYING PROCESS OF INSECTS OR PLANTS, USUALLY IN LABRATORY PROCESS. PROMOTES DRYING OF LIVING TISSUE, SUCH AS TOPS OF UNWANTED PLANTS
FUMIGANTS	THESE PRODUCE VAPOURS OR GASES TO CONTROL AIR or SOIL BORNE INSECTS AND DISEASES.
FUNGICIDES	THIS GROUP DESTROYS FUNGI THAT INFECT ANIMALS, PLANTS or PEOPLE
HERBICIDES	THIS GROUP IS USED TO KILL WEEDS AND OTHER PLANTS THAT ARE GROWING or COMPETING WITH THE DESIRED SPECIES
INSECT GROWTH REGULATORS (IGR's)	THESE ACCELERATE or RETARD THE GROWTH RATE OF THE INSECTS
INSECTICIDES	USED TO CONTROL OR ELIMINATE INSECTS THAT AFFECT ANIMALS, PLANTS or PEOPLE
MITICIDES (Acaricides)	THESE KILL MITES THAT LIVE ON PLANTS, LIVESTOCK or EVEN PEOPLE
MOLLUSCICIDES	THESE ARE USED TO KILL SNAILS AND SLUGS
NEMATICIDES	USED TO KILL NEMATODES, WHICH ARE MICROSCOPIC WORMLIKE ORGANISMS THAT LIVE IN THE SOIL AND CAN CAUSE EXTENSIVE DAMAGE TO FOOD CROPS
OVICIDES	THESE ARE USED TO CONTROL THE INSECT'S EGGS
PISCICIDES	THESE ARE USED TO CONTROL PEST FISH
PLANT GROWTH REGULATORS (PGR's)	USED TO ACCELERATE or RETARD THE GROWTH RATE OF A SPECIFIC PLANT. SUBSTANCES (excluding Fertilizers or other plant nutrients) THAT ALTER THE EXPECTED GROWTH, FLOWERING, or THE REPRODUCTION RATE OF A PLANT
PREDACIDES	USED TO CONTROL VERTEBRATE PESTS (Birds, Mammals or Reptiles)
REPELLENTS	USED IN REPELLING PESTS SUCH AS MOSQUITOES, FLIES, TICKS and FLEAS
RODENTICIDES	USED TO KILL RATS, MICE or OTHER TYPES OF RODENTS

CHART SHOWING THE GROUPS OF PESTICIDES AND THEIR USES

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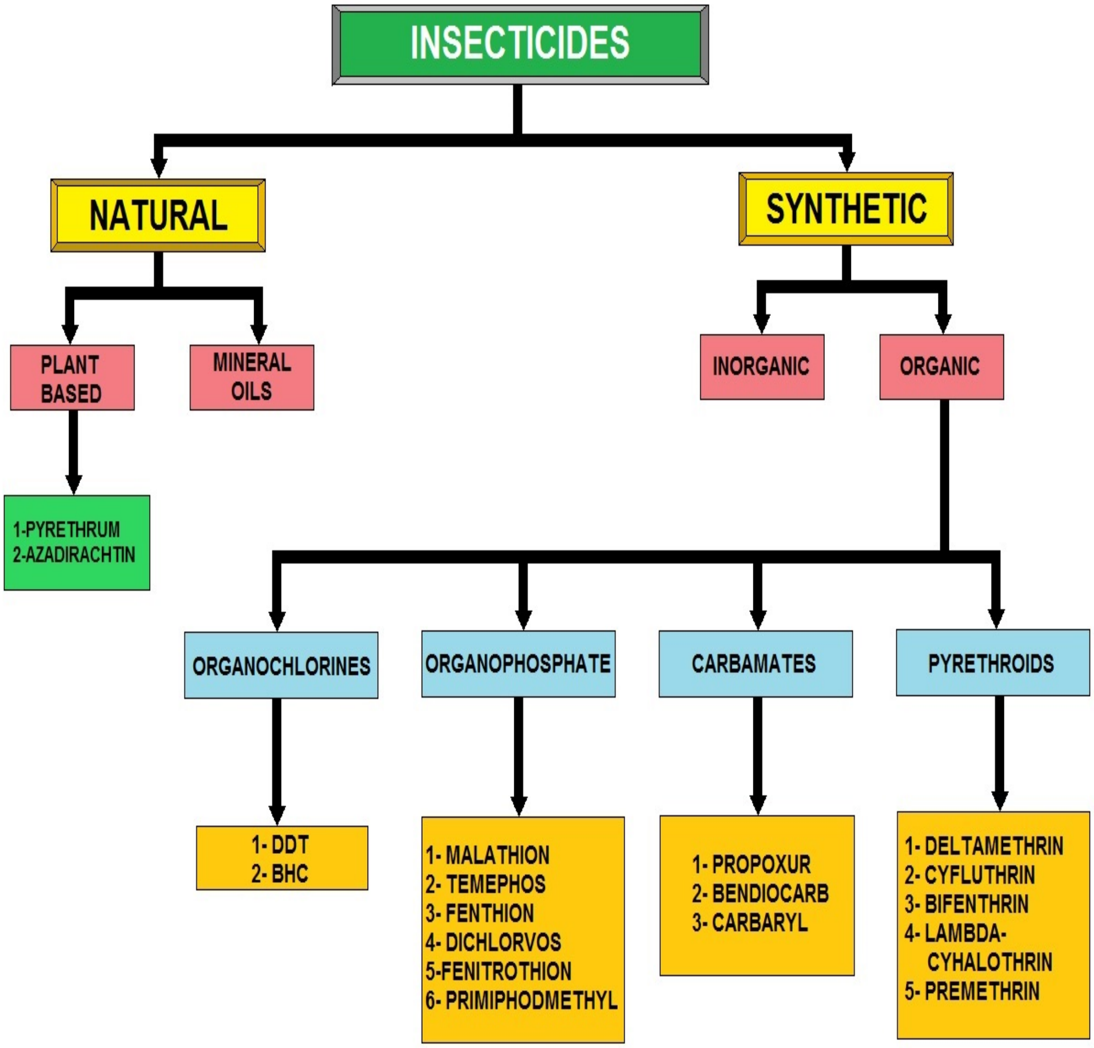

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PESTICIDES BASED UPON CHEMICAL COMPOSITION

Topic 1 - Pesticide Section

Section Focus: You will learn the basics of pesticides. At the end of this section, you will be able to describe pesticide and chemical applications and safety procedures. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

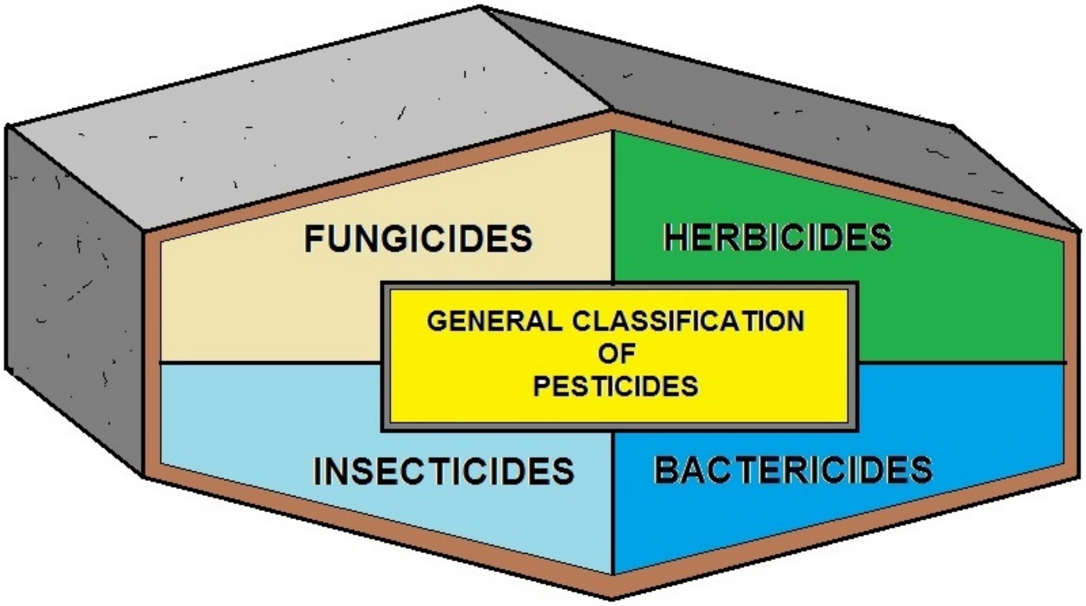
Scope/Background: Pesticides are toxic to both pests, non-pests and humans. Pesticides are commonly used to protect homes and crops from insects, diseases, and weeds. Because chemical pesticides are toxic to the target pest, they can also be harmful to human health and/or the environment.

Did you know that all of these common products are considered pesticides?

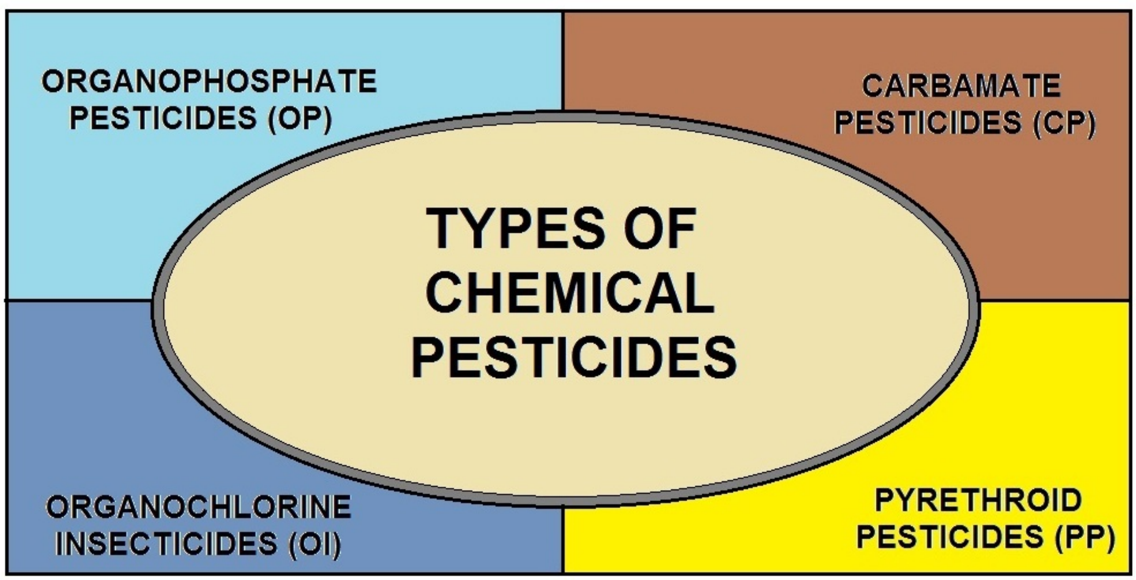
- Cockroach sprays and baits
- Insect repellents for personal use.
- Rat and other rodent poisons.
- Flea and tick sprays, powders, and pet collars.
- Kitchen, laundry, and bath disinfectants and sanitizers.
- Products that kill mold and mildew.
- Some lawn and garden products, such as weed killers.
- Some swimming pool chemicals.

By their very nature, most pesticides create some risk of harm to humans, animals, or the environment because they are designed to kill or otherwise adversely affect living organisms. At the same time, pesticides are useful to society because of their ability to kill potential disease-causing organisms and control insects, weeds, and other pests.

In the United States, the Office of Pesticide Programs of the Environmental Protection Agency is chiefly responsible for regulating pesticides. Biologically-based pesticides, such as pheromones and microbial pesticides are becoming increasingly popular and often are safer than traditional chemical pesticides.

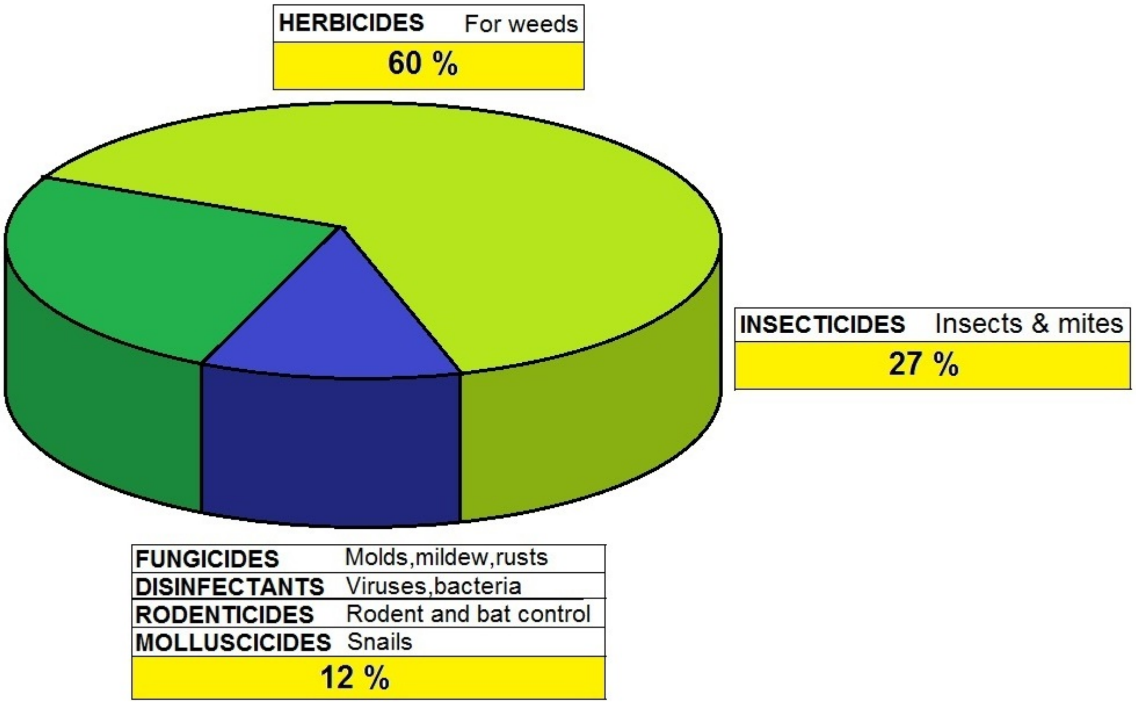


PESTICIDE CLASSIFICATION #1



PESTICIDE TYPES DIAGRAM #1

Common Insecticides



PESTICIDE USAGE BY TYPE DIAGRAM

An insecticide is a pesticide used against insects. They include ovicides and larvicides used against the eggs and larvae of insects respectively. The use of insecticides is believed to be one of the major factors behind the increase in agricultural productivity in the 20th century. Nearly all insecticides have the potential to significantly alter ecosystems; many are toxic to humans; and others are concentrated in the food chain. This course contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

Evaluating Pesticides EPA

All pesticides sold or distributed in the United States must be registered by EPA, based on scientific studies showing that they can be used without posing unreasonable risks to people or the environment.

Because of advances in scientific knowledge, the law requires that pesticides which were first registered before November 1, 1984, be reregistered to ensure that they meet today's more stringent standards.

In evaluating pesticides for reregistration, EPA obtains and reviews a complete set of studies from pesticide producers, describing the human health and environmental effects of each pesticide. The Agency develops any mitigation measures or regulatory controls needed to effectively reduce each pesticide's risks. EPA then reregisters pesticides that can be used without posing unreasonable risks to human health or the environment. When a pesticide is eligible for reregistration, EPA explains the basis for its decision in a Reregistration Eligibility Decision (RED) document.

Classes of Insecticides

The classification of insecticides is done in several different ways:

- Contact insecticides are toxic to insects brought into direct contact. Efficacy is often related to the quality of pesticide application, with small droplets (such as aerosols) often improving performance.
- Inorganic insecticides are manufactured with metals and include arsenates, copper compounds and fluorine compounds, which are now seldom used, and sulfur, which is commonly used.
- Mode of action—how the pesticide kills or inactivates a pest—is another way of classifying insecticides. Mode of action is important in predicting whether an insecticide will be toxic to unrelated species, such as fish, birds and mammals.
- Natural insecticides, such as nicotine, pyrethrum and neem extracts are made by plants as defenses against insects. Nicotine based insecticides have been barred in the U.S. since 2001 to prevent residues from contaminating foods.
- Organic insecticides are synthetic chemicals which comprise the largest numbers of pesticides available for use today.
- Plant-Incorporated Protectants (PIP) are insecticidal substances produced by plants after genetic modification. For instance, a gene that codes for a specific Baccilus thuringiensis biocidal protein is introduced into a crop plant's genetic material. Then, the plant manufactures the protein. Since the biocide is incorporated into the plant, additional applications at least of the same compound are not required.
- Systemic insecticides are incorporated by treated plants. Insects ingest the insecticide while feeding on the plants.
- Heavy metals, e.g. arsenic have been used as insecticides; they are poisonous and very rarely used now by farmers.

Common Kinds of Pesticides and their Function

Algaecides
Control algae in lakes, canals, swimming pools, water tanks, and other sites.

Antifouling agents
Kill or repel organisms that attach to underwater surfaces, such as boat bottoms.

Antimicrobials
Kill microorganisms (such as bacteria and viruses).

Attractants
Attract pests (for example, to lure an insect or rodent to a trap).
(However, food is not considered a pesticide when used as an attractant.)

Biocides
Kill microorganisms.

Disinfectants and sanitizers
Kill or inactivate disease-producing microorganisms on inanimate objects.

Fungicides
Kill fungi (including blights, mildews, molds, and rusts).

Fumigants
Produce gas or vapor intended to destroy pests in buildings or soil.

Herbicides
Kill weeds and other plants that grow where they are not wanted.

Insecticides
Kill insects and other arthropods.

Miticides (also called acaricides)
Kill mites that feed on plants and animals.

Microbial pesticides
Microorganisms that kill, inhibit, or out compete pests, including insects or other microorganisms.

Molluscicides
Kill snails and slugs.

Nematicides
Kill nematodes (microscopic, worm-like organisms that feed on plant roots).

Ovicides
Kill eggs of insects and mites.

Pheromones
Biochemicals used to disrupt the mating behavior of insects.

Repellents
Repel pests, including insects (such as mosquitoes) and birds.

Rodenticides
Control mice and other rodents.

The term pesticide also includes these substances:

Defoliants
Cause leaves or other foliage to drop from a plant, usually to facilitate harvest.

Desiccants
Promote drying of living tissues, such as unwanted plant tops.

Insect growth regulators
Disrupt the molting, maturity from pupal stage to adult or other life processes of insects.

Plant growth regulators
Substances (excluding fertilizers or other plant nutrients) that alter the expected growth, flowering, or reproduction rate of plants.

Pest Control Devices

What about pest control devices? The EPA also has a role in regulating devices used to control pests. More specifically, a ***"device"*** is any instrument or contrivance (other than a firearm) intended for trapping, destroying, repelling, or mitigating any pest. A black light trap is an example of a device. Unlike pesticides, EPA does not require devices to be registered with the Agency. Devices are subject to certain labeling, packaging, record keeping, and import/export requirements, however.

What is <u>not</u> a pesticide? The U.S. definition of pesticides is quite broad, but it does have some exclusions:

- Drugs used to control diseases of humans or animals (such as livestock and pets) are not considered pesticides; such drugs are regulated by the Food and Drug Administration.

- Fertilizers, nutrients, and other substances used to promote plant survival and health are not considered plant growth regulators and thus are not pesticides.

- Biological control agents, except for certain microorganisms, are exempted from regulation by the EPA. (Biological control agents include beneficial predators such as birds or ladybugs that eat insect pests.)

- Products which contain certain low-risk ingredients, such as garlic and mint oil, have been exempted from Federal registration requirements, although State regulatory requirements may still apply. For a list of ingredients which may be exempt, and a discussion of allowable label claims for such products, see the EPA's Pesticide Registration Notice 2000-6, *"Minimum Risk Pesticides Exempted under FIFRA Section 25(b)."*

COMMON COCKROACH TREATMENTS

Service Technician

The term ‘‘service technician’’ means any individual who uses or supervises the use of pesticides (other than a ready to use consumer products pesticide) for the purpose of providing structural pest control or lawn pest control on the property of another for a fee. The term ‘‘service technician’’ does not include individuals who use antimicrobial pesticides, sanitizers or disinfectants; or who otherwise apply ready to use consumer products pesticides.

This course contains EPA’s federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA’s regulations and these are frequently changed. Check with your state environmental/pesticide agency for more information.

Antimicrobial Pesticides

Antimicrobial pesticides, such as disinfectants & sanitizers, are pesticides that are intended to "(i) disinfect, sanitize, reduce, or mitigate growth or development of microbiological organisms; or (ii) protect inanimate objects (for example floors and walls), industrial processes or systems, surfaces, water, or other chemical substances from contamination, fouling, or deterioration caused by bacteria, viruses, fungi, protozoa, algae, or slime." This category does not include certain pesticides intended for food use; but does encompass pesticides with a wide array of other uses. For example, antimicrobial pesticides act as preserving agents in paints, metalworking fluids, wood supports, and many other products to prevent their deterioration.

Antimicrobials are especially important because many are public health pesticides. They help to control microorganisms (viruses, bacteria, and other microorganisms) that can cause human disease.

Antimicrobial public health pesticides are used as disinfectants in medical settings, where they are present in products used in cleaning cabinets, floors, walls, toilets, and other surfaces. Proper use of these disinfectants is an important part of infection control activities employed by hospitals and other medical establishments.

Only antimicrobial products from the primary registrants are included in the lists. All the EPA's registered pesticides must have an EPA registration number (EPA Reg #). The EPA Registration number for primary registrants consists of two set of numbers separated by a hyphen (-), for example EPA Reg#001234-000012.

The first set of numbers refers to the registrant's identification number and the second set of numbers represents the product identification number. A distributor's product may use a different name, but must have the first two sets of EPA Reg # of the primary registrant, plus a third set of numbers that represents the Distributor/ Relabeler Identification number, for example EPA Reg#001234-000012-000567.

An establishment number (EPA Est #) is the place where the pesticide, formulation or device is produced and it is indicated by a set of codes which consist of the registrant's number followed by the State where the product is made and facility number.

The approved label of a particular antimicrobial product can be found in the *Pesticide Product Label System (PPLS)* using the EPA registration number of the primary product.

For additional information please contact the Antimicrobials Division hotline at 703-308-0127, 703-308-6467 (FAX) or send an email to *info_antimicrobial@epa.gov*

Biopesticides

Biopesticides are certain types of pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals. For example, canola oil and baking soda have pesticidal applications and are considered biopesticides. At the end of 2001, there were approximately 195 registered biopesticide active ingredients and 780 products. Biopesticides fall into three major classes:

(1) Microbial pesticides consist of a microorganism (e.g., a bacterium, fungus, virus or protozoan) as the active ingredient. Microbial pesticides can control many different kinds of pests, although each separate active ingredient is relatively specific for its target pest[s]. For example, there are fungi that control certain weeds, and other fungi that kill specific insects.

The most widely used microbial pesticides are subspecies and strains of *Bacillus thuringiensis*, or Bt. Each strain of this bacterium produces a different mix of proteins, and specifically kills one or a few related species of insect larvae. While some Bt's control moth larvae found on plants, other Bt's are specific for larvae of flies and mosquitoes. The target insect species are determined by whether the particular Bt produces a protein that can bind to a larval gut receptor, thereby causing the insect larvae to starve.

(2) Plant-Incorporated-Protectants (PIPs) are pesticidal substances that plants produce from genetic material that has been added to the plant. For example, scientists can take the gene for the Bt pesticidal protein, and introduce the gene into the plant's own genetic material. Then the plant, instead of the Bt bacterium, manufactures the substance that destroys the pest. The protein and its genetic material, but not the plant itself, are regulated by the EPA.

(3) Biochemical pesticides Biochemical pesticides are naturally occurring substances that control pests by non-toxic mechanisms. Conventional pesticides, by contrast, are generally synthetic materials that directly kill or inactivate the pest. Biochemical pesticides include substances, such as insect sex pheromones that interfere with mating as well as various scented plant extracts that attract insect pests to traps. Because it is sometimes difficult to determine whether a substance meets the criteria for classification as a biochemical pesticide, the EPA has established a special committee to make such decisions.

What are the advantages of using biopesticides?
Biopesticides are usually inherently less toxic than conventional pesticides.

Biopesticides generally affect only the target pest and closely related organisms, in contrast to broad spectrum, conventional pesticides that may affect organisms as different as birds, insects, and mammals.

Biopesticides often are effective in very small quantities and often decompose quickly, thereby resulting in lower exposures and largely avoiding the pollution problems caused by conventional pesticides. When used as a component of Integrated Pest Management (IPM) programs, biopesticides can greatly decrease the use of conventional pesticides, while crop yields remain high. To use biopesticides effectively, however, users need to know a great deal about managing pests.

Federal Insecticide, Fungicide, and Rodenticide Act (or **FIFRA**)

The **Federal Insecticide, Fungicide, and Rodenticide Act** (or **FIFRA**), (P.L. 75-717) 7 U.S.C. § 136 *et seq*. is a United States federal law that set up the basic U.S. system of pesticide regulation to protect applicators, consumers and the environment. It is administered by the Environmental Protection Agency (EPA) and the appropriate environmental agencies of the respective states. The current version of FIFRA underwent a major revision in 1972 and superseded the Federal Insecticide Act of 1910 and the Federal Insecticide, Fungicide, and Rodenticide Act of 1947. In 1988, it was amended to change pesticide registration laws and to require reregistration of certain pesticides that had been registered before 1984. The act was amended again in 1996 by the Food Quality Protection Act. Distribution and use of pesticides is regulated by the Environmental Protection Agency.

When FIFRA was first passed in 1947, it gave the United States Department of Agriculture responsibility for regulating pesticides. In 1972, when FIFRA underwent a major revision, it transferred responsibility of pesticide regulation to the Environmental Protection Agency and shifted emphasis to protection of the environment and public health. The 1972 version is largely still in place.

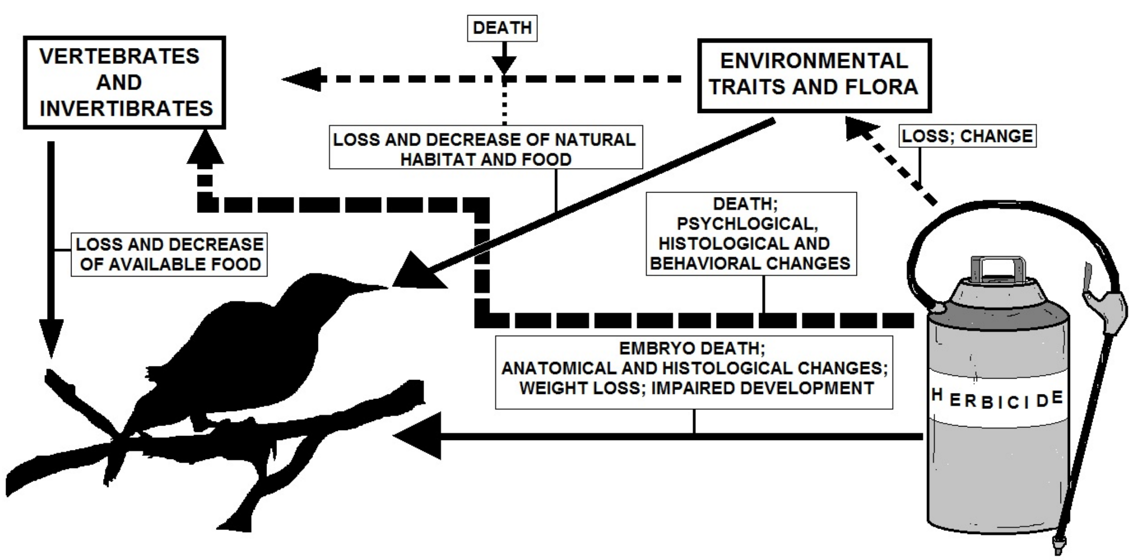
FIFRA established a set of pesticide regulations:

1. FIFRA established registration for all pesticides, which is only done after a period of data collection to determine the effectiveness for its intended use, appropriate dosage, and hazards of the particular material. When registered, a label is created to instruct the final user the proper usage of the material. If instructions are ignored, users are liable for any negativeconsequences. Label directions are designed to maximize the effectiveness of the product, while protecting the applicator, consumers, and the environment. Critics of the process point out on the one hand that the research to produce the label is entirely done by the manufacturer and not much checking is done on its accuracy. On the other hand some consider the process too strict. It costs millions of dollars and often several years to register a pesticide, which limits production only to large players. Likewise many smaller or specialty uses are never registered, because the companies do not consider the potential sales sufficient to justify the investment.

2. Only a few pesticides are made available to the general public. Most pesticides are considered too hazardous for general use, and are restricted to certified applicators. FIFRA established a system of examination and certification both at the private level and at the commercial level for applicators who wish to purchase and use restricted use pesticides. The distribution of restricted pesticides is also monitored.

3. The EPA has different review processes for three categories of pesticides: antimicrobials, biopesticides, and conventional pesticides. The three categories have a similar application process, but have different data requirements and review policies. Depending on the category of pesticide, the review process can take several years. After a pesticide is registered with the EPA, there may be state registration requirements to consider.

THE LABEL IS THE LAW.



INDIRECT & DIRECT EFFECTS OF HERBICIDES ON BIRDS

Technical Learning College

Insect Growth Regulators Introduction

An insect growth regulator (IGR) is a synthetic chemical that mimics insect hormones. Hormones regulate a wide array of body and growth (physiological) functions. IGRs may interfere with molting, pupal emergence, or body wall formation. IGRs are often specific for an insect species or a group of very closely related species. They often have delayed effects because they are taken into the insect and stored until the insect reaches the right growth stage. This may range from days to weeks or even months. For example, if the IGR stops the insect from molting and a given insect is exposed just after a molt, it would continue to function normally until the next molt before dying.

Reduced Risk
Many IGRs are labeled "reduced risk" by the Environmental Protection Agency, meaning that they target juvenile harmful insect populations while causing less detrimental effects to beneficial insects. Unlike classic insecticides, IGRs do not affect an insect's nervous system and are thus more worker-friendly within closed environments. IGRs are also more compatible with pest management systems that use biological controls. In addition, while insects can become resistant to insecticides, they are less likely to become resistant to IGRs.

Hormonal IGRs
Hormonal IGRs typically work by mimicking or inhibiting the juvenile hormone (JH), one of the two major hormones involved in insect molting. IGRs can also inhibit the other hormone, ecdysone, large peaks of which trigger the insect to molt.

If JH is present at the time of molting, the insect molts into a larger larval form; if absent, it molts into a pupa or adult. IGRs that mimic JH can produce premature molting of young immature stages, disrupting larval development.

They can also act on eggs, causing sterilization, disrupting behavior or disrupting diapause, the process that causes an insect to become dormant before winter. IGRs that inhibit JH production can cause insects to prematurely molt into a nonfunctional adult. IGRs that inhibit ecdysone can cause pupal mortality by interrupting the transformation of larval tissues into adult tissues during the pupal stage.

Chitin Synthesis Inhibitors
Chitin synthesis inhibitors work by preventing the formation of chitin, a carbohydrate needed to form the insect's exoskeleton. With these inhibitors, an insect grows normally until it molts. The inhibitors prevent the new exoskeleton from forming properly, causing the insect to die. Death may be quick, or take up to several days depending on the insect. Chitin synthesis inhibitors can also kill eggs by disrupting normal embryonic development. Chitin synthesis inhibitors affect insects for longer periods of time than hormonal IGRs. These are also quicker acting but can affect predaceous insects, arthropods and even fish.

In the case of termite control, the slow action of the IGR allows the chemical to be widely spread throughout the colony as the termite workers feed and groom one another. IGRs are, in general, environmentally safe and have very low mammalian toxicity. Some examples are hexaflumuron, diflubenzuron, pyriproxyfen, and methoprene.

Hexaflumuron

Hexaflumuron (hexaflumeron) is an insect growth regulator that interferes with insects' chitin synthesis. It was registered in 1994 — the first active ingredient to be registered as a "reduced risk pesticide" through the U.S. Environmental Protection Agency's (EPA's) reduced risk program, which waives tests for new pesticides that are thought to pose fewer hazards than existing pesticides. It is registered for use on termites, and is the active ingredient in the Sentricon™ bait system. It functions by inhibiting the synthesis of chitin, the material that makes up the exoskeleton of insects (Cox, 1997).

Hexaflumuron is a benzoyl-phenylurea termiticide registered for use to control Eastern and Formosan subterranean termites. It is registered for use in above- and below-ground termite bait station systems in food and nonfood areas. Treatment sites may include interior and exterior surfaces of buildings and crawl spaces, fences, utility poles, decking, landscape decorations, trees, and other features which could be damaged by termite foraging and feeding activity.

Hexaflumuron is not approved for use in indoor residences. While it is not a restricted use product, hexaflumuron is sold in conjunction with a service provided by pest-control operators licensed by the state to apply termiticides. As hexaflumuron was first registered in 1994, it was not subject to the reregistration process as required by FIFRA.

The Agency anticipates conducting an ecological risk assessment for hexaflumuron, including an endangered species assessment. For human health, risk assessments may be required if there are changes in current use patterns. Below is a summary of the issues relevant to the registration review process of hexaflumuron.

Environmental Fate and Ecological Risk:

• The application method for hexaflumuron (i.e., bait stations), is viewed by the Agency as a “closed system” with minimal likelihood of environmental exposure. No previous ecological risk assessments or drinking water exposure assessments have been conducted for hexaflumuron.

• The Agency has not conducted a risk assessment that supports a complete endangered species determination. The ecological risk assessment planned during registration review will allow the Agency to determine whether hexaflumuron use has “no effect” or “may affect” federally listed threatened or endangered species (listed species) or their designated critical habitats. When an assessment concludes that a pesticide’s use “may affect” a listed species or its designated critical habitat, the Agency will consult with the U.S. Fish and Wildlife Service and/or National Marine Fisheries Service (the Services), as appropriate.

• Considering the environmental fate properties of hexaflumuron and the method of application (i.e., bait stations), hexaflumuron has the potential to enter into the environment via termites eating the bait and then transporting it away from the bait station. Once in the termite, hexaflumuron could be transferred to termite predators, such as birds and mammals. Based on the fate properties of hexaflumuron, it has the potential to bioaccumulate in food webs. Another possible route of exposure where uncertainty exists is the ability of non-target terrestrial invertebrates, such as native ground-dwelling pollinators, to enter the hexaflumuron bait stations. Therefore, future ecological risk assessments of hexaflumuron will include assessing risks associated with exposures of terrestrial animals to hexaflumuron through consumption of contaminated termites and non-target terrestrial invertebrates that may enter bait stations.

• Hexaflumuron's mode of action, fate and transport properties, and toxicity to non-target terrestrial species create the potential for hexaflumuron to reduce survival, reproduction, and/or growth in non-target terrestrial animals including birds, mammals, amphibians, reptiles and terrestrial insects when used in accordance with the current label. These non-target organisms include federally listed threatened and endangered species as well as non-listed species.
• Based on the application methods (i.e., above- and below-ground bait stations) and the environmental fate properties for hexaflumuron, the potential for hexaflumuron to migrate to the soil and to further migrate to surface water and/or groundwater sources is considered minimal. Therefore, ecological risk to aquatic organisms is expected to be low. In addition, unless the use patterns for hexaflumuron change, a drinking water exposure assessment will not be required to support registration review.

Human Health Risk
• Because of the low toxicity of hexaflumuron, and the low-exposure scenarios associated with hexaflumuron products, a human health risk assessment has not been previously conducted.
• Given the current uses, the Agency does not anticipate conducting a human health risk assessment for hexaflumuron to support registration review. However, if in the future new uses or use patterns emerge, human health risk assessments that examine the dietary, residential, aggregate, or occupational risks of hexaflumuron may be required.
• Based on the Agency's review of the available human health toxicity and exposure data for hexaflumuron, no additional data are expected to be required to support registration review.

Diflubenzuron

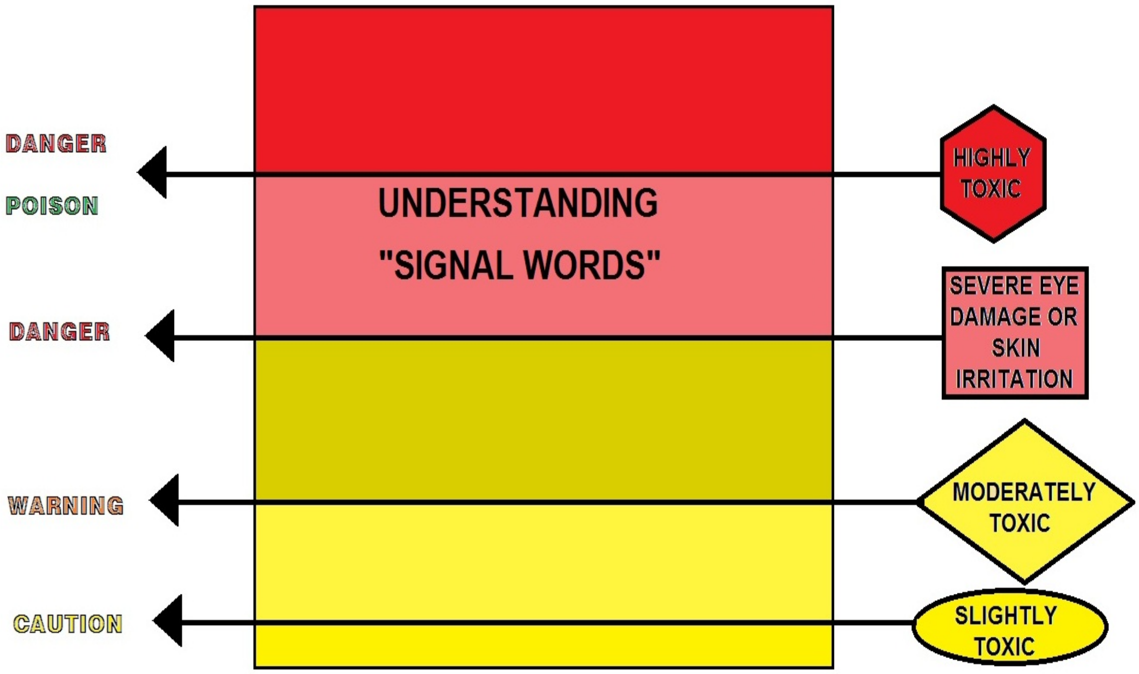
Diflubenzuron is an insecticide of the benzamide class. It is used in forest management and on field crops to selectively control insect pests. The mechanism of action of diflubenzuron involves inhibiting the production of chitin, which is used by an insect to build its exoskeleton.

Diflubenzuron is an acaricide/insecticide (insect growth regulator) used to control many leaf-eating larvae of insects feeding on agricultural, forest and ornamental plants (e.g. gypsy moths, mosquito larvae, rust mites).

Diflubenzuron is used primarily on cattle, citrus, cotton, mushrooms, ornamentals, standing water, forestry trees and in programs to control mosquito larvae and gypsy moth populations. Formulations include a soluble concentrate, flowable concentrate, wettable powder and a pelleted/tableted. Diflubenzuron is applied by airblast, aircraft and hydraulic sprayers.

Regulatory History
Diflubenzuron was first registered as a pesticide in the U.S. in 1976. EPA issued a Registration Standard for diflubenzuron in September 1985 (PB86-176500). A November 1991 Data Call-In (DCI) required additional residue chemistry and ecological effects data. Currently, 29 diflubenzuron products are registered.

Pesticide - Human Health Factors



PESTICIDE SIGNAL WORDS DIAGRAM

Assessment Toxicity
In studies using laboratory animals, diflubenzuron generally has been shown to be slightly toxic on an acute basis. It is absorbed by the dermal route and has been placed in Toxicity Category III (the second lowest of four categories). It has also been placed in Toxicity Category IV (the lowest of four categories) for ingestion by the oral and inhalation routes.

Occupational and Residential Exposure
Based on current use patterns, handlers (mixers, loaders, and applicators) may be exposed to diflubenzuron during and after normal use of applications in agricultural and other settings. The Agency is establishing a short-term (1 to 7 days) toxicological endpoint of sulfhemoglobinemia and intermediate-term (1 week to several months) toxicological endpoint of methemoglobinemia.

Human Risk Assessment
Diflubenzuron generally is of low acute toxicity, but affects the hemoglobin of animal in studies. Although the Agency has determined that there is no evidence of carcinogenicity for iflubenzuron per se (Group E); p-chloroaniline (PCA), a metabolite of diflubenzuron, is a probable human carcinogen (Group B2). The Agency has also determined that pchlorophenylurea (CPU), a metabolite of diflubenzuron that is closely related to PCA but has no adequate carcinogenicity data, is considered as having the same carcinogenicity potential (Q1*) as PCA. The total cancer risk estimate for PCA and related metabolites for the overall U.S. population is 1 X 10-6. The Rfd is 0.02 mg/kg/day, based on the NOEL of

2.0 mg/kg/day in the 52-week chronic oral study in dogs with a safety factor of 100 to account for interspecies extrapolation and intraspecies variability.

Occupational Exposure
Of greater concern is the risk posed to diflubenzuron handlers, particularly mixers/loaders/applicators. The risk for short-term occupational exposure is acceptable for handlers wearing long-sleeved shirts, long pants and chemical-resistant gloves. The risk for intermediate term occupational exposure is also acceptable, provided dust/mist respirators (TC-21C) are required for mixers, loaders and applicators when working with diflubenzuron for certain higher risk application methods.

Restricted Entry Interval
Post-application re-entry workers will be required to observe a 12-hour Restricted Entry Interval, as set by the WPS. Under the Food Quality Protection Act of 1996, the Agency has determined that there is a reasonable certainty that no harm will result to infants and children from aggregate exposure to diflubenzuron.

The total dietary cancer risk for the published tolerances for the overall U.S. population is approximately 1 x 10-6. Since there are no detections of diflubenzuron in ground water, dietary risk from drinking water are expected to be negligible.

Based on very low residues detected in forestry dissipation studies, a low dermal absorption rate, and extremely low dermal and inhalation toxicity, occupational uses of diflubenzuron in residential locations, parks, or forests treated with diflubenzuron are expected to result in insignificant risk.

Ecological Effects
Diflubenzuron is practically non-toxic to avian species, small mammals, freshwater fish and marine/estuarine fish on an acute oral dietary basis, while it is slightly toxic to avian species on a subacute dietary basis.

Diflubenzuron is non-toxic to bees. The results indicate that diflubenzuron is very highly toxic to freshwater aquatic invertebrates, including marine/estuarine crustacea, while it is highly toxic to marine/estuarine mollusks. The results indicate that diflubenzuron affects reproduction, growth and survival in freshwater invertebrates as well as reproduction in marine/estuarine invertebrates.

Pyriproxyfen
Pyriproxyfen is a pyridine based pesticide which is found to be effective against a variety of arthropoda. It was introduced to the US in 1996 to protect cotton crops against whitefly. It has also found useful for protecting other crops. It is also being used as a prevention for fleas on household pets.

Pyriproxyfen is a juvenile hormone analogue, preventing larvae from developing into adulthood and thus rendering them unable to reproduce. In the US pyriproxyfen is often marketed under the trade name Nylar. In Europe pyriproxyfen is known under the brand names Cyclio (Virbac) and Exil Flea Free TwinSpot (Emax).

Methoprene

Methoprene is a juvenile hormone (JH) analog which can be used as an insecticide that acts as a growth regulator. Methoprene is an amber-colored liquid with a faint fruity odor which is essentially nontoxic to humans when ingested or inhaled. It is used in drinking water cisterns to control mosquitoes which spread malaria.

Methoprene is an insect growth regulator (IGR) with activity against a variety of insect species including horn flies, mosquitoes, beetles, tobacco moths, sciarid flies, fleas (eggs and larvae), fire ants, pharaoh ants, midge flies and Indian meal moths. Controlling some of these insects, methoprene is used in the production of a number of foods including meat, milk, mushrooms, peanuts, rice and cereals. It also has several uses on domestic animals (pets) for controlling fleas.

Methoprene products are sold under a number of trade names including Altosid, Precor, Kaba, Pharorid, Dianex, Apex, Fleatrol, Ovitrol, Extinguish and Diacon. Methoprene is considered a biochemical pesticide because rather than controlling target pests through direct toxicity, Methoprene interferes with an insect’s life cycle and prevents it from reaching maturity or reproducing.

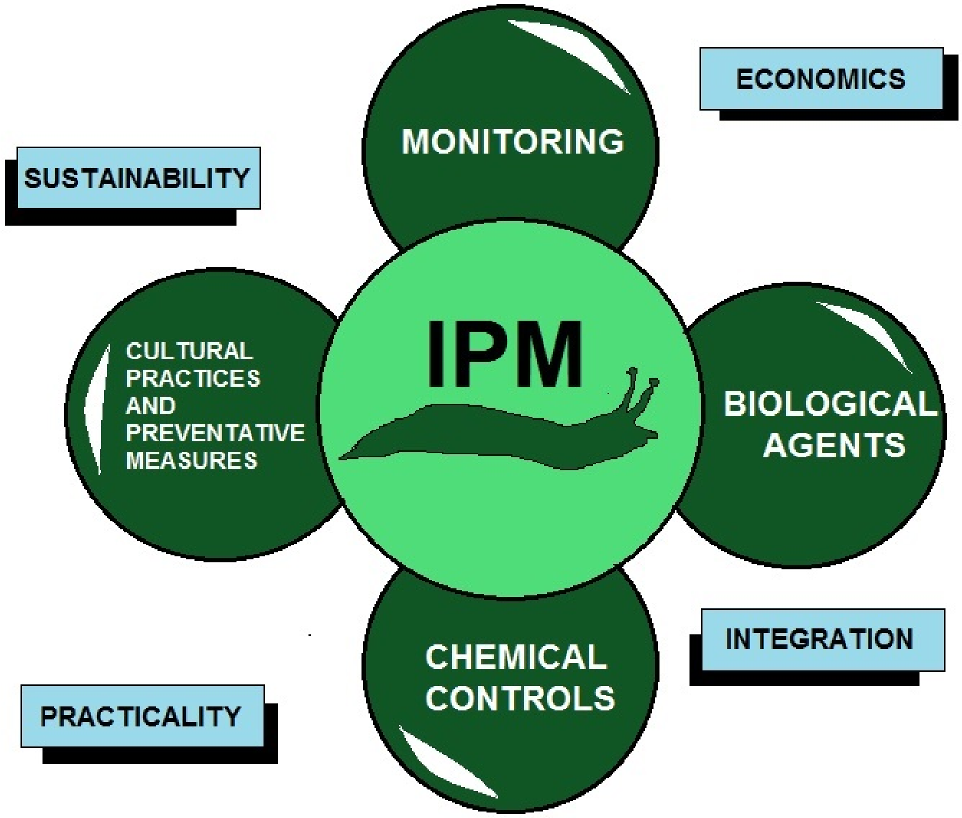
Health Effects

An extensive safety data base has been generated for Methoprene since it was first registered in 1975. Toxicological data on file with the Agency includes an acute toxicity battery, irritation/sensitization studies, sub-chronic feeding studies, developmental and reproductive toxicity studies, mutagenicity studies, chronic feeding studies and lifetime carcinogenicity studies. In addition, special studies dealing with the metabolism and fate of Methoprene in several mammalian species and those dealing with the potential for endocrine effects have also been completed. Studies relating to the effect of Methoprene on the immune system were waived by EPA since there was no indication of the immune system being the potential target organ/system in any of the acute, sub-chronic, chronic, teratology, reproduction or special toxicity studies. Today, some of the submitted data would not even be required under the current guidelines for biochemical pesticides.

Regulatory Conclusions

- The studies available to EPA indicate that the biochemical insect growth regulator Methoprene is of low toxicity and poses very little hazard to people and other non-target species.
- Ecological concerns contained in the 1991 Methoprene R.E.D. FACTS document related to toxicity to estuarine invertebrates have been alleviated as a result of submission of the estuarine invertebrate life cycle toxicity study in 1996, which indicated minimal chronic risk to Mysid Shrimp.
- All Methoprene end-use products completed the reregistration process in 1997 and all reregistration data requirements and label changes have been completed.

IPM Methods (Types of Pest Control)



INTEGRATED PEST MANAGEMENT DIAGRAM #1

Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.

The IPM approach can be applied to both agricultural and non-agricultural settings, such as the home, garden, and workplace. IPM takes advantage of all appropriate pest management options including, but not limited to, the judicious use of pesticides. In contrast, organic food production applies many of the same concepts as IPM but limits the use of pesticides to those that are produced from natural sources, as opposed to synthetic chemicals.

IPM is not a single pest control method but, rather, a series of pest management evaluations, decisions and controls. In practicing IPM, growers who are aware of the potential for pest infestation follow a four-tiered approach.

The four steps include:

Set Action Thresholds

Before taking any pest control action, IPM first sets an action threshold, a point at which pest populations or environmental conditions indicate that pest control action must be taken. Sighting a single pest does not always mean control is needed. The level at which pests will either become an economic threat is critical to guide future pest control decisions.

Monitor and Identify Pests

Not all insects, weeds, and other living organisms require control. Many organisms are innocuous, and some are even beneficial. IPM programs work to monitor for pests and identify them accurately, so that appropriate control decisions can be made in conjunction with action thresholds. This monitoring and identification removes the possibility that pesticides will be used when they are not really needed or that the wrong kind of pesticide will be used.

Prevention

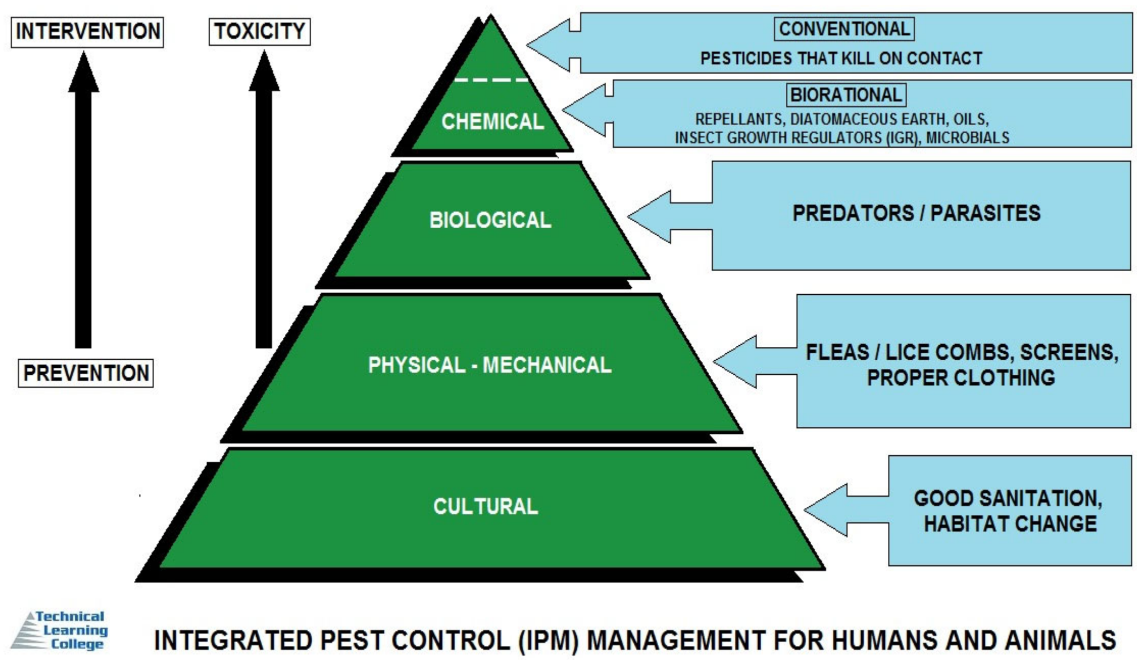
As a first line of pest control, IPM programs work to manage the crop, lawn, or indoor space to prevent pests from becoming a threat. In an agricultural crop, this may mean using cultural methods, such as rotating between different crops, selecting pest-resistant varieties, and planting pest-free rootstock. These control methods can be very effective and cost-efficient and present little to no risk to people or the environment.

Control

Once monitoring, identification, and action thresholds indicate that pest control is required, and preventive methods are no longer effective or available, IPM programs then evaluate the proper control method both for effectiveness and risk. Effective, less risky pest controls are chosen first, including highly targeted chemicals, such as pheromones to disrupt pest mating, or mechanical control, such as trapping or weeding.

If further monitoring, identifications and action thresholds indicate that less risky controls are not working, then additional pest control methods would be employed, such as targeted spraying of pesticides. Broadcast spraying of non-specific pesticides is a last resort.

Six Basic Components of IPM



INTEGRATED PEST CONTROL (IPM) MANAGEMENT FOR HUMANS AND ANIMALS

An IPM system is designed around six basic components: The US Environmental Protection Agency has a useful set of IPM principles.

1. Acceptable pest levels: The emphasis is on control, not eradication. IPM holds that wiping out an entire pest population is often impossible, and the attempt can be economically expensive, environmentally unsafe, and frequently unachievable. IPM programs first work to establish acceptable pest levels, called action thresholds, and apply controls if those thresholds are crossed. These thresholds are pest and site specific, meaning that it may be acceptable at one site to have a weed such as white clover, but at another site it may not be acceptable. By allowing a pest population to survive at a reasonable threshold, selection pressure is reduced. This stops the pest gaining resistance to chemicals produced by the plant or applied to the crops. If many of the pests are killed then any that have resistance to the chemical will form the genetic basis of the future, more resistant, population. By not killing all the pests there are some un-resistant pests left that will dilute any resistant genes that appear.

2. Preventive cultural practices: Selecting varieties best for local growing conditions, and maintaining healthy crops, is the first line of defense, together with plant quarantine and 'cultural techniques' such as crop sanitation (e.g. removal of diseased plants to prevent spread of infection).

3. Monitoring: Regular observation is the cornerstone of IPM. Observation is broken into two steps, first; inspection and second; identification.

Visual inspection, insect and spore traps, and other measurement methods and monitoring tools are used to monitor pest levels. Accurate pest identification is critical to a successful IPM program. Record-keeping is essential, as is a thorough knowledge of the behavior and reproductive cycles of target pests. Since insects are cold-blooded, their physical development is dependent on the temperature of their environment. Many insects have had their development cycles modeled in terms of degree days. Monitor the degree days of an environment to determine when is the optimal time for a specific insect's outbreak.

4. Mechanical controls: Should a pest reach an unacceptable level, mechanical methods are the first options to consider. They include simple hand-picking, erecting insect barriers, using traps, vacuuming, and tillage to disrupt breeding.

5. Biological controls: Natural biological processes and materials can provide control, with minimal environmental impact, and often at low cost. The main focus here is on promoting beneficial insects that eat target pests. Biological insecticides, derived from naturally occurring microorganisms (e.g.: Bt, entomopathogenic fungi and entomopathogenic nematodes), also fit in this category.

6. Responsible Pesticide Use: Synthetic pesticides are generally only used as required and often only at specific times in a pests life cycle. Many of the newer pesticide groups are derived from plants or naturally occurring substances (e.g.: nicotine, pyrethrum and insect juvenile hormone analogues), but the toxophore or active component may be altered to provide increased biological activity or stability. Further 'biology-based' or 'ecological' techniques are under evaluation.

Main Focus of IPM Programs

An IPM regime can be quite simple or sophisticated. Historically, the main focus of IPM programs was on agricultural insect pests. Although originally developed for agricultural pest management, IPM programs are now developed to encompass diseases, weeds, and other pests that interfere with the management objectives of sites such as residential and commercial structures, lawn and turf areas, and home and community gardens.

IPM is applicable to all types of agriculture and sites such as residential and commercial structures, lawn and turf areas, and home and community gardens.

Reliance on knowledge, experience, observation, and integration of multiple techniques makes IPM a perfect fit for organic farming (sans artificial pesticide application). For large-scale, chemical-based farms, IPM can reduce human and environmental exposure to hazardous chemicals, and potentially lower overall costs of pesticide application material and labor.

1. Proper identification of pest - What is it?

Cases of mistaken identity may result in ineffective actions. If plant damage due to over-watering are mistaken for fungal infection, spray costs can be incurred, and the plant is no better off.

2. **Learn pest and host life cycle and biology.**
At the time you see a pest, it may be too late to do much about it except maybe spray with a pesticide. Often, there is another stage of the life cycle that is susceptible to preventative actions. For example, weeds reproducing from last year's seed can be prevented with mulches. Also, learning what a pest needs to survive allows you to remove these.

3. Monitor or sample environment for pest population - How many are here?
Preventative actions must be taken at the correct time if they are to be effective. For this reason, once the pest is correctly identified, monitoring must begin before it becomes a problem. For example, in school cafeterias where roaches may be expected to appear, sticky traps are set out before school starts. Traps are checked at regular intervals so populations can be monitored and controlled before they get out of hand. Some factors to consider and monitor include: Is the pest present/absent? What is the distribution - all over or only in certain spots? Is the pest population increasing or decreasing?

4. Establish action threshold (economic, health or aesthetic) - How many are too many?
In some cases, a certain number of pests can be tolerated. Soybeans are quite tolerant of defoliation, so if there are a few caterpillars in the field and their population is not increasing dramatically, there is not necessarily any action necessary. Conversely, there is a point at which action must be taken to control cost. For the farmer, that point is the one at which the cost of damage by the pest is more than the cost of control. This is an economic threshold. Tolerance of pests varies also by whether or not they are a health hazard (low tolerance) or merely a cosmetic damage (high tolerance in a non-commercial situation).

Different sites may also have varying requirements based on specific areas. White clover may be perfectly acceptable on the sides of a tee box on a golf course, but unacceptable in the fairway where it could cause confusion in the field of play.

5**. Choose an appropriate combination of management tactics**
For any pest situation, there will be several options to consider. Options include mechanical or physical control, cultural controls, biological controls and chemical controls. Mechanical or physical controls include picking pests off plants, or using netting or other material to exclude pests such as birds from grapes or rodents from structures. Cultural controls include keeping an area free of conducive conditions by removing or storing waste properly, removing diseased areas of plants properly. Biological controls can be support either through conservation of natural predators or augmentation of natural predators.

Augmentative control includes the introduction of naturally occurring predators at either an inundative or inoculative level. An inundative release would be one that seeks to inundate a site with a pest's predator to impact the pest population.

An inoculative release would be a smaller number of pest predators to supplement the natural population and provide ongoing control.

Chemical controls would include horticultural oils or the application of pesticides such as insecticides and herbicides. A Green Pest Management IPM program would use pesticides derived from plants, such as botanicals, or other naturally occurring materials.

6. Evaluate results - How did it work?
Evaluation is often one of the most important steps. This is the process to review an IPM program and the results it generated. Asking the following questions is useful: Did actions have the desired effect?

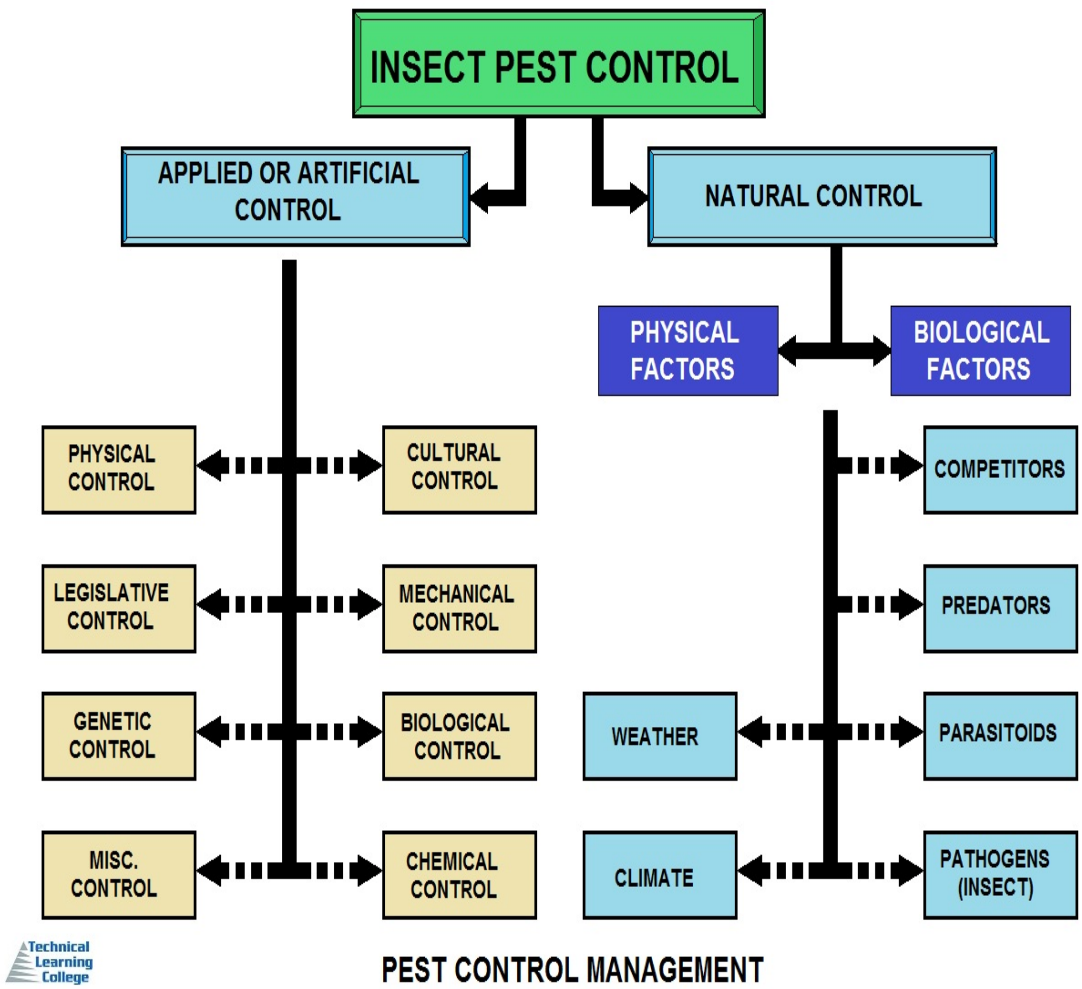
Was the pest prevented or managed to farmer satisfaction?

Was the method itself satisfactory?

Were there any unintended side effects?

What can be done in the future for this pest situation?

Understanding the effectiveness of the IPM program allows the site manager to make modifications to the IPM plan prior to pests reaching the action threshold and requiring action again.



PEST CONTROL MANAGEMENT

Adjuvants Introduction

Activity of Adjuvants

Adjuvants, or additive compounds, aid in the mixing, application or effectiveness of pesticides. One class of adjuvants, **compatibility agents**, allow uniform mixing of compounds that would normally separate. Other types of adjuvants include **spreaders**, **stickers**, and **synergists**. There are nearly as many adjuvants as there are pesticides, and they provide a choice for every need. Some adjuvants are added during pesticide manufacture and are, thus, part of the formulation. Other adjuvants are added just before application. To decide when to use an adjuvant, ***READ THE LABEL.*** It will state when a particular adjuvant is needed, whether or not one should be added or when one is already present.

Adjuvants assist application or pesticide activity without being directly toxic to pests. However, many of these chemicals can present hazards to the applicators. The EPA has not required manufacturers to perform the same type of research and reporting on adjuvants that is required for pesticide registration. However, regulations are continually updated to protect the health of applicators and review and registration of adjuvants may be required in the future. Meanwhile, it is a good practice to use the same care in handling adjuvants as is used with pesticides.

Many, but not all, adjuvants function as **surfactants**, or surface active agents. Surfactants improve the retention and absorption of herbicides. The benefit that they provide is offset, to a degree, by the increased drift hazard they cause. Reducing the surface tension of the spray solution permits it to break up into finer droplets, which are more likely to drift off target.

Drift control agents are adjuvants that help reduce the risk of drift. Pesticide drift is off-target spray deposit and off-target damage.

Spray thickeners reduce drift by increasing droplet size and by reducing bounce or runoff during application. Use of these adjuvants helps to comply with drift regulations, which is especially important in areas adjacent to residential areas. Lo-Drift, Nalco-Trol and Drift Proof are examples of drift control agents.

Penetrating agents dissolve the waxy layer that protects the surface of leaves. This speeds up absorption with foliar treatments. Lower application rates used with these adjuvants may provide the same control as higher rates made without them; more chemical enters the plant before breaking down or washing off. Examples of penetrating agents include Arborchem and kerosene.

Proper Handling of Pesticides

Using pesticides involves many responsibilities beyond the immediate needs of pest control. Greenhouse growers, like all agricultural producers, are expected to handle hazardous materials in a manner that reduces the exposure risk to other persons and limits contamination of the environment.

Numerous federal and state regulations exist to help growers handle, store and apply pesticides properly.

In addition to FIFRA, the EPA has further authority over pesticide use under the Superfund Amendment and Reauthorization Act (**SARA**) and the Resource Conservation and Recovery Act (**RCRA**). These federal regulations cover all materials classified as hazardous and, therefore, apply to pesticides. Pesticide handling and storage are also regulated by the Transportation Safety Act and the Occupational Safety and Health Act (**OSHA**).

Moving Pesticides

Interstate transport of pesticides is regulated by the Federal Department of Transportation (**DOT**). Their guidelines for safe movement are common sense rules for any transport of chemicals. All pesticides should be in the original DOT approved containers and correctly labeled. All containers should be secured against movement that could result in breaking or spilling. Never transport pesticides in a vehicle that also carries food or feed products.

Never transport pesticides in the cab of vehicles. Paper or cardboard containers should be protected from moisture. Never leave an open-bed truck containing pesticides unattended. Following these procedures is necessary when moving concentrated chemicals and is good practice for diluted mixtures.

Persons transporting chemicals must have proper protective clothing available for the safe handling of the containers. The protective gear should be in or on the vehicle for immediate access in case a spill occurs. Protection of the person managing or cleaning up a spill is the primary concern.

Spill Cleanup and Reporting

What to do when a spill occurs

When a minor spill occurs, make sure the proper protective equipment is available, and wear it. If pesticide has spilled on anyone, wash it off immediately, before taking any other action. Confine the spill with a dike of sand or soil. Use absorbent materials to soak up the spill. Shovel all contaminated material into a leak- proof container and dispose of it in the same manner as excess pesticides. Do not hose down the area; this spreads the chemical. Always work carefully to avoid making mistakes.

Streams and wetlands must be protected in the event of an accidental spill of any size. Even diluted chemicals pose a threat to natural habitats when released in large amounts. Extra precautions must be taken when drawing water from streams or ponds. Antisiphoning devices must be used and be in good working order. Tank mixes should be prepared at least ¼ mile from water resources. If this is not possible, make sure the ground at the mixing site does not slope toward the water, or construct an earthen dike to prevent pesticides from flowing into bodies of water or drains.

Major spills of concentrates or large quantities of spray solution are difficult to handle without assistance. Provide any first aid that is needed and confine the spill, then notify the proper authorities. Contact the local fire department using the 911 system, if available. Other phone numbers for fire departments, state and local authorities should be carried in the vehicles and by the applicators.

Regardless of the size of the spill, keep people away from the chemicals. Rope off the area and flag it to warn others. Do not leave the site unless responsible help, such as emergency or enforcement personnel, is there to warn others.

Significant pesticide spills must be reported to your state pesticide lead agency. Applicators, or their employers, are responsible for telephoning a spray incident report to the State Agency as soon as practical after emergency health care and efforts to contain the spill have started.

The state agencies decide if it is necessary to call **CHEMTREC** (Chemical Transportation Emergency Center), a public service of the Manufacturing Chemicals Association located in Washington, DC CHEMTREC provides immediate advice for those at the scene of an emergency. This service is available 24 hours a day (1-800-424-9300) for emergencies only.

Decontamination

(1) Decontamination solutions can be used for decontaminating surfaces and materials where spills of dust, granular, wettable powders, or liquid pesticides have occurred. The bulk of the spilled pesticide should be cleaned up or removed prior to applying any decontaminant.

(2) Several materials may be used to decontaminate pesticides. Due to the many different pesticides available and the necessity to use the correct decontamination material, all decontamination activities must be carried out only after appropriate decontamination methods have been determined by the Environmental Coordinator and/or Spill Response Team. Many pesticides, especially the organophosphates, decompose when treated with lye, or lime. Fewer pesticides are decomposed by bleach. Other pesticides cannot be effectively decontaminated and should only be treated with detergent and water to assist in removal. The following table is a guide for decontaminating certain pesticides:

Use Lye or Lime for:	**Use Chlorine Bleach for:**	**Do not use any decontamination Chemicals for these Pesticides:**
acephate	calcium cyanide	alachlor
atrazine	chlorpyrifos	chloramben
captan	fonophos	chlorinated hydrocarbons
carbaryl		diuron
dalapon		methoxychlor
diazinon		pentachlorophenol
dichlorvos		picloram
dimethoate		2,4-D
malathion		bromacil
naled		glyphosate
propoxur		simazine

WARNING: There is a slight potential for creating toxic by-products when using these procedures. In critical situations, samples of affected soil, sediment, water, etc. should be sent to a laboratory for analysis to determine if decontamination was successful.

Pesticides amenable to treatment using lye or lime may be decontaminated when mixed with an excess quantity of either of these materials. Lye or lime can be used in either the dry form or as a 10% solution in water. Caution: caustic soda (lye) can cause severe eye damage to personnel not properly protected.

Protect against contact by wearing unventilated goggles, long-sleeved work clothes with coveralls, neoprene gloves, and a chemical-resistant apron. An approved respirator should also be worn. Do not use lye on aluminum surfaces.

Bleach
For pesticides that can be degraded by treatment with bleach, in general use one gallon of household bleach (which contains approximately 5% sodium hypochlorite) per pound or gallon of pesticide spilled. If bleaching powder is used, first mix it with water (one gallon of water per pound of bleach) and add a small amount of liquid detergent. For safety reasons, a preliminary test must be run using small amounts of bleach and the spilled pesticide. The reaction resulting from this test must be observed to make sure the reaction is not too vigorous. Do not store in close proximity to, or mix chlorine bleach with, amine-containing pesticides. Mingling of these materials can cause a violent reaction resulting in fire. Calcium hypochlorite is not recommended as a decontaminating agent because of the fire hazard. Spilled granular/bait materials need only to be swept up. When there is doubt concerning which decontaminant is appropriate, only water and detergent should be used.

Nonporous surfaces should be washed with detergent and water. The decontamination solution determined to be correct should be thoroughly worked into the surface. The decontamination solution should then be soaked up using absorbent material. The spent absorbent material is then placed into a labeled leakproof container for disposal.

Porous materials such as wood may not be adequately decontaminated. If contamination is great enough to warrant, these materials should be replaced. Tools, vehicles, aircraft, equipment and any contaminated metal or other nonporous objects can be readily decontaminated using detergent and the appropriate decontamination solution.

Disposal
All contaminated materials that cannot be effectively decontaminated as described above must be placed in properly labeled, sealed, leakproof containers. Disposal of these containers shall be in accordance with instructions determined by the U.S. Environmental Protection Agency/State Pesticide Agency and the Spill Response Team.

Common and unnecessary sight at several aerial applicators in the U.S. several empty pesticide cans.

Organochlorine Compounds

The insecticidal properties of the best known representative of this class of insecticides, DDT, was made by the Swiss Scientist Paul Müller. For this discovery, he was awarded the Nobel Prize for Physiology or Medicine in 1948. DDT was introduced on the market in 1944. With the rise of the modern chemical industry, it was possible to make chlorinated hydrocarbons. DDT works by opening the sodium channels in the nerve cells of the insect. A number of the organochlorine pesticides have been banned from most uses worldwide, and globally they are controlled via the Stockholm Convention on persistent organic pollutants. These include: aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex and toxaphene.

Penta or Pentachlorophenol

Penta or Pentachlorophenol (PCP) is an organochlorine compound used as a pesticide and a disinfectant. First produced in the 1930s, it is marketed under many trade names. It can be found in two forms: PCP itself or as the sodium salt of PCP, which dissolves easily in water.

In the past, PCP has been used as an herbicide, insecticide, fungicide, algaecide, disinfectant and as an ingredient in antifouling paint. Some applications were in agricultural seeds (for nonfood uses), leather, masonry, wood preservation, cooling tower water, rope and paper mill system. Its use has been significantly declined due to the high toxicity of PCP and its slow biodegradation. There are two general methods for preserving wood. The pressure process method involves placing wood in a pressure-treating vessel where it is immersed in PCP and then subjected to applied pressure. In the non-pressure process method, PCP is applied by spraying, brushing, dipping, and soaking. Utility companies save millions of dollars in replacement poles, because the life of these poles increases from approximately 7 years for an untreated pole to about 35 years for a preservative-treated pole.

PCP has been detected in surface waters and sediments, rainwater, drinking water, aquatic organisms, soil, and food, as well as in human milk, adipose tissue, and urine. As PCP is generally used for its properties as a biocidal agent, there is considerable concern about adverse ecosystem effects in areas of PCP contamination.

Releases to the environment are decreasing as a result of declining consumption and changing use methods. However, PCP is still released to surface waters from the atmosphere by wet deposition, from soil by run off and leaching, and from manufacturing and processing facilities. PCP is released directly into the atmosphere via volatilization from treated wood products and during production. Finally, releases to the soil can be by leaching from treated wood products, atmospheric deposition in precipitation (such as rain and snow), spills at industrial facilities and at hazardous waste sites.

Since the early 1980s, the purchase and use of PCP in the U.S has not been available to the general public. Nowadays most of the PCP used in the U.S is restricted to the treatment of utility poles and railroad ties. In the United States, any drinking water supply with a PCP concentration exceeding the MCL, 1 ppb, must be notified by the water supplier to the public. Disposal of PCP and PCP contaminated substances are regulated under RCRA as a F-listed hazardous waste.

Organophosphates

The next large class developed was the organophosphates, which bind to acetylcholinesterase and other cholinesterases. This results in disruption of nerve impulses, killing the insect or interfering with its ability to carry on normal functions. Organophosphate insecticides and chemical warfare nerve agents (such as sarin, tabun, soman and VX) work in the same way. Organophosphates have an accumulative toxic effect to wildlife, so multiple exposures to the chemicals amplify the toxicity.

Carbamates

Carbamate insecticides have similar toxic mechanisms to organophosphates, but have a much shorter duration of action and are thus somewhat less toxic.

Organophosphates and Carbamates Pesticides

Organophosphates are phosphoric acid esters or thiophosphoric acid esters. When developed in the 1930s and 1940s, their original compounds were highly toxic to mammals. Organophosphates manufactured since then are less toxic to mammals but toxic to target organisms, such as insects. Malathion, dibrom, chlorpyrifos, temephos, diazinon and terbufos are organophosphates. Carbamates are esters of N-methyl carbamic acid. Aldicarb, carbaryl, propoxur, oxamyl and terbucarb are carbamates.

Although these pesticides differ chemically, they act similarly. When applied to crops or directly to the soil as systemic insecticides, organophosphates and carbamates generally persist from only a few hours to several months. However, they have been fatal to large numbers of birds on turf and in agriculture, and negatively impacted breeding success in birds. Many organophosphates are highly toxic to aquatic organisms.

These are two very large families of insecticides. Indeed, they have been the primary insecticides for the past 25 to 30 years. They range in toxicity from slightly to highly toxic. They are formulated in all kinds of ways from highly concentrated emulsifiable concentrates (ECs) to very dilute granular (G) formulations.

These insecticide families are similar in their modes of action—they are all nervous system poisons. Insects and all other animals, including humans, have nervous systems that are susceptible. Both insecticide families are efficiently absorbed by inhalation, ingestion, and skin penetration. To a degree, the extent of poisoning depends on the rate at which the pesticide is absorbed.
Organophosphates break down chiefly by hydrolysis in the liver; rates of hydrolysis vary widely from one compound to another. With certain organophosphates whose breakdown is relatively slow, significant amounts may be temporarily stored in body fat. The organophosphates and carbamates replaced the chlorinated hydrocarbons (e.g., chlordane, aldrin, and heptachlor) for all uses, including termite control. Examples of organophosphates are chlorpyrifos for termite control and diazinon for other household pests. An example of a carbamate is carbaryl, also used for household and lawn pests.

How can people be exposed to organophosphate and carbamate pesticides?
People can be exposed to organophosphates and carbamates pesticides through accidental exposure during use. People can accidentally inhale the pesticides if they are in an area where they were recently applied. The chemicals can be ingested with food or drinks that are contaminated.

How can these pesticides exhaust affect my health?
Acetylcholinesterase is an enzyme found in the nervous system, red blood cells and blood plasma. These pesticides damage nerve function by acting as acetylcholinesterase inhibitors in the nervous system.

Breathing - Short-term exposure can produce muscle twitching, headache, nausea, dizziness, loss of memory, weakness, tremor, diarrhea, sweating, salivation, tearing, constriction of pupils, and slowed heartbeat.

Long-term exposure can produce delayed neurotoxicity, such as tingling and burning in the extremities. This delayed neurotoxicity can progress to paralysis and is seldom reversible. Damage to the liver, kidney, immune system and bone marrow may occur. Some carbamates are also suspected carcinogens.

What should I do if exposed to these pesticides?
If you think you were exposed to these pesticides, contact your doctor.

Is there a medical test to show whether I was exposed to these pesticides?

The level of cholinesterase activity in red blood cells or plasma helps physicians determine exposure to these pesticides. However, other chemicals or disease states can alter acetylcholinesterase activity. Urine or blood tests only apply if a person was exposed to a large quantity. Persons who will use these pesticides regularly should ask their physician to establish a baseline value prior to prolonged use, followed by monthly monitoring.

Pyrroles
Chlorfenapyr is the only termiticide from the pyrrole family of chemistry and is active primarily as a stomach poison with some contact activity. It is also non-repellent to termites. Chlorfenapyr is registered as a termiticide under the tradename Phantom®. Chlorfenapyr acts on the mitochondria of cells and uncouples or inhibits oxidative phosphorylation, preventing the formation of the crucial energy molecule adenosine triphosphate (ATP). As a result, energy production in the cells shuts down, resulting in cellular and, ultimately, termite death.

Fiproles (or Phenylpyrazoles)
Fipronil is the only insecticide in this new class, introduced in 1990 and registered in the U.S. in 1996. It is marketed as a termiticide under the tradename Termidor®. This termiticide is a non-repellent material with contact and stomach activity. Fipronil works by blocking the gamma-aminobutyric acid (GABA) regulated chloride channel in neurons, thus disrupting the activity of the insect's central nervous system.

Pyrethroids

To mimic the insecticidal activity of the natural compound pyrethrum another class of pesticides, pyrethroid pesticides, has been developed. These are non-persistent, which is a sodium channel modulators, and are much less acutely toxic than organophosphates and carbamates. Compounds in this group are often applied against household pests.

The pyrethroids are a large family of modern synthetic insecticides similar to the naturally derived botanical pyrethrins. They are highly repellent to MOST INSECTS AND ESPECIALLY termites, which may contribute to the effectiveness of the termiticide barrier. They have been modified to increase their stability in the natural environment. They are widely used in agriculture, homes, and gardens. Some examples are bifenthrin, cyfluthrin, cypermethrin, deltamethrin, and permethrin. They may be applied alone or in combination with other insecticides. Pyrethroids are formulated as emusifiable concentrates (EC), wettable powders (WP), granulars (G), and aerosols. Certain pyrethroids exhibit striking neurotoxicity in laboratory animals when administered by intravenous injection, and some are toxic by the oral route.

Systemic toxicity by inhalation and dermal absorption are low, however—there have been very few systemic poisonings of humans by pyrethroids. Though limited absorption may account for the low toxicity of some pyrethroids, rapid biodegradation by mammalian liver enzymes (ester hydrolysis and oxidation) is probably the major factor responsible. This course contains pesticide recommendations that are subject to change at any time.
These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them.

If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

Most pyrethroid metabolites are promptly excreted, at least in part, by the kidney. In response to dermal exposure, some persons may experience a skin sensitivity called paresthesia. The symptoms are similar to sunburn sensation of the face and especially the eyelids. Sweating, exposure to sun or heat, and application of water aggravate the disagreeable sensations. This is a temporary effect that dissipates within 24 hours. For first aid, wash with soap and water to remove as much residue as possible, and then apply a vitamin E oil preparation or cream to the affected area. Paresthesia is caused more by pyrethroids whose chemical makeup includes cyano- groups: fenvalerate, cypermethrin, and fluvalinate. In addition to protecting themselves from future exposure, persons who have experienced paresthesia should choose a pyrethroid with a different active ingredient, as well as a wettable powder or microencapsulated formulation.

About These Pesticides
Pyrethrins and pyrethroids are insecticides included in over 3,500 registered products, many of which are used widely in and around households, including on pets, in mosquito control, and in agriculture. The use of pyrethrins and pyrethroids has increased during the past decade with the declining use of organophosphate pesticides, which are more acutely toxic to birds and mammals than the pyrethroids. This change to less acutely toxic pesticides, while generally beneficial, has introduced certain new issues. For example, residential uses of pyrethrins and pyrethroids may result in urban runoff, potentially exposing aquatic life to harmful levels in water and sediment.

Pyrethrins are botanical insecticides derived from chrysanthemum flowers most commonly found in Australia and Africa. They work by altering nerve function, which causes paralysis in target insect pests, eventually resulting in death.

Pyrethroids are synthetic chemical insecticides whose chemical structures are adapted from the chemical structures of the pyrethrins and act in a similar manner to pyrethrins. Pyrethroids are modified to increase their stability in sunlight.

Most pyrethrins and some pyrethroid products are formulated with synergists, such as piperonyl butoxide and MGK-264, to enhance the pesticidal properties of the product. These synergists have no pesticidal effects of their own but enhance the effectiveness of other chemicals.
* Pyrethrins, a single pesticide active ingredient, contain six components that have insecticidal activity:

Pyrethrin 1, pyrethrin 2, cinerin 1, cinerin 2, jasmolin 1, and jasmolin 2

Pyrethroids include:
Allethrin stereoisomers, Bifenthrin, Beta-Cyfluthrin, Cyfluthrin, Cypermethrin, Cyphenothrin, Deltamethrin, Esfenvalerate, Fenpropathrin, Tau-Fluvalinate, Lambda-Cyhalothrin, Gamma Cyhalothrin, Imiprothrin, 1RS cis-Permethrin, Permethrin, Prallethrin, Resmethrin, Sumithrin (d-phenothrin), Tefluthrin, Tetramethrin, Tralomethrin, and Zeta-Cypermethrin

Synergists include:
MGK-264 and Piperonyl butoxide

Permethrin

General Information

Permethrin is a broad-spectrum pyrethroid insecticide. It is available in dusts, emulsifiable concentrates, smokes, ULV concentrates, and wettable-powder formulations.

The historical development of the synthetic pesticides called pyrethroids is based on the pyrethrins, which are derived from chrysanthemums. Pyrethrins are a "natural" environmental product that is of low toxicity to mammals. They are highly photolabile and degrade quickly in sunlight, and the cost of reapplying them has limited their widespread agricultural use. Pyrethroids have been synthesized to be similar to pyrethrins yet more stable in the environment. Evidence suggests that they have a very large margin of safety when used as directed by the label (Aldridge, 1990; Chen et al., 1991; Snodgrass, 1992).

Commercial pyrethroid products commonly use petroleum distillates as carriers. Some commercial products also contain OP or carbamate insecticides because the rapid paralytic effect of pyrethrins on insects ("quick knockdown") is not always lethal (Cheremisinoff and King, 1994). Pyrethroids are formulated as emulsifiable concentrates, wettable powders, granules, and concentrates for ULV application.

Borates

“Borate” is a generic term for compounds containing the elements boron and oxygen. Boron never occurs alone naturally but as calcium and sodium borate ores in several places in the world.

Borax and other sodium borates are used in numerous products such as laundry additives, eye drops, fertilizers, and insecticides. Though the mechanisms of toxicity are not fully understood, boron is very toxic to insects and decay fungi that commonly damage wood in structures. At low levels, however, boron is only minimally toxic, and perhaps beneficial, to humans, other mammals, and growing plants. Use of borate-treated wood for construction of homes and their wood-based contents appears to offer many advantages to today’s environmentally sensitive world.

Unlike most other wood preservatives and organic insecticides that penetrate best in dry wood, borates are diffusible chemicals—they penetrate unseasoned wood by diffusion, a natural process. Wood moisture content and method and length of storage are the primary factors affecting penetration by diffusion. Properly done, diffusion treatments permit deep penetration of large timbers and refractory (difficult-to-treat) wood species that cannot be treated well by pressure. The diffusible property of borates can be manipulated in many ways; suitable application methods range from complex automated industrial processes to simple brush or injection treatments.

Application methods include momentary immersion by bulk dipping; pressure or combination pressure/diffusion treatment; treatment of composite boards and laminated products by treatment of the wood finish; hot and cold dip treatments and long soaking periods; spray or brush-on treatments with borate slurries or pastes; and placement of fused borate rods in holes drilled in wood already in use. This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

Neonicotinoids

Neonicotinoids are synthetic analogues of the natural insecticide nicotine (with a much lower acute mammalian toxicity and greater field persistence). These chemicals are nicotinic acetylcholine receptor agonists. Broad-spectrum—systemic insecticides, they have a rapid action (minutes-hours). They are applied as sprays, drenches, seed and soil treatments—often as substitutes for organophosphates and carbamates. Treated insects exhibit leg tremors, rapid wing motion, stylet withdrawal (aphids), disoriented movement, paralysis and death.

Biological Insecticides

Recent efforts to reduce broad spectrum toxins added to the environment have brought biological insecticides back into vogue. An example is the development and increase in use of Bacillus thuringiensis, a bacterial disease of Lepidopterans and some other insects. Toxins produced by different strains of this bacterium are used as a larvicide against caterpillars, beetles, and mosquitoes. Because it has little effect on other organisms, it is considered more environmentally friendly than synthetic pesticides. The toxin from B. thuringiensis (Bt toxin) has been incorporated directly into plants through the use of genetic engineering. Other biological insecticides include products based on entomopathogenic fungi (e.g. Beauveria bassiana, Metarhizium anisopliae), nematodes (e.g. Steinernema feltiae) and viruses (e.g. Cydia pomonella granulovirus).

Anti-feedants

Many plants have evolved substances, like polygodial, which prevent insects from eating, but do not kill them directly. The insect often remains nearby, where it dies of starvation. Since anti-feedants are nontoxic, they would be ideal as insecticides in agriculture. Much agrochemical research is devoted to make them cheap enough for commercial use.

Polygodial is an active constituent of Dorrigo Pepper, Mountain Pepper, Horopito, Canelo, Paracress and Water-pepper. It elicits a warm and pungent flavor.

The biological activity of polygodial has been reported in the scientific literature to include antifungal and antimicrobial activities, antihyperalgesia, potent attachment-inhibitory activity, insect antifeedant activity, antinociception, vasorelaxation action in vessels of rabbit and guinea pig, anti-inflammatory and anti-allergic activities.

Polygodial's primary antifungal action is as a nonionic surfactant, disrupting the lipid-protein interface of integral proteins nonspecifically, denaturing their functional conformation. It is also likely that polygodial permeates by passive diffusion across the plasma membrane, and once inside the cells may react with a variety of intracellular compounds. It is also used as an insecticide for its antifeedant property, which causes insects to starve.

Rotenone

Rotenone is an odorless chemical that is used as a broad-spectrum insecticide, piscicide, and pesticide. It occurs naturally in the roots and stems of several plants such as the jicama vine plant. In mammals, including humans, it is linked to the development of Parkinson's disease.

Rotenone is used in solution as a pesticide and insecticide, or in emulsified liquid form as a piscicide. People catch fish by extracting rotenone from plants and releasing it into water. Poisoned fish come to the surface and are easily caught. This method was first practiced by various indigenous tribes who smashed the roots. Fish caught this way can be eaten because rotenone is very poorly absorbed by the gastrointestinal tract of humans, whereas it is lethal to fish because it readily enters the blood stream of the fish through the gills.

Small-scale sampling with rotenone is used by fish researchers studying the biodiversity of marine fishes to collect cryptic, or hidden, fishes, which represent an important component of shoreline fish communities. Rotenone is the most effective tool available because only small quantities are necessary. It has only minor and transient environmental side-effects.

Rotenone is also used in powdered form to reduce parasitic mites on chickens and other fowl. In the United States and in Canada, all uses of rotenone except as a piscicide (fish killer) are being phased out.

Rotenone is sold as an organic pesticide dust for the garden. Unselective in action, it kills potato beetles, cucumber beetles, flea beetles, cabbage worms, raspberry bugs, and asparagus bugs, as well as most other arthropods. Rotenone rapidly bio-degrades under warm conditions so there is minimal harmful residue. A light dusting on the leaves of plants will control insects for several days. It is not known to be harmful to humans when used properly. However, a recent report from the National Institutes of Health finds statistically significant associations between use of either rotenone or paraquat with Parkinson's disease.

Rotenone is produced by extraction from the roots and stems of several tropical and subtropical plant species, especially those belonging to the genus Lonchocarpus or Derris.

Some of the plants containing rotenone:

- Hoary Pea or Goat’s Rue (Tephrosia virginiana) – North America
- Jícama (Pachyrhizus erosus) – North America
- Cubé Plant or Lancepod (Lonchocarpus utilis) – South America
- The root extract is referred to as Cubé resin
- Barbasco (Lonchocarpus urucu) – South America
- The root extract is referred to as Cubé resin
- Tuba Plant (Derris elliptica) – southeast Asia & southwest Pacific islands

The root extract is referred to as Derris or Derris root

- Jewel Vine (Derris involuta) – southeast Asia & southwest Pacific islands

Among the Mizo tribes of India (Derris walchii/D. thyrsiflora) the tender root is eaten as vegetable. The root extract is referred to as Derris or Derris root

Check with your state environmental/pesticide agency for more information.

Pesticide Safety Introduction
Information about Cleaning PPE and Protection yourself from Pesticides

1. The clothing and protective equipment items you will be cleaning may have pesticides on them.

2. Although you may not be able to see or smell the pesticides, they can rub off on you when you touch the clothing and equipment.

3. If pesticides get on you, they can hurt you. They can:
• cause skin rashes or burns,
• go through your skin and into your body and make you ill,
• burn your eyes,
• make you ill if you breathe them or get them in your mouth.

4. To avoid harm from the pesticide, you should:
• Pour the clothes from their container into the washer without touching them.
• Handle only the inner surfaces, such as the inside of boots, aprons, or coveralls.
• Do not breathe the steam from the washer and dryer.

5. Pesticides should not be allowed to stay on your hands:
• When you wash clothing or equipment by hand, use plenty of water and rinse your hands often.
• Wash your hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
• Wash your hands as soon as you finish handling the clothing or equipment.

6. You should not allow clothing and equipment with pesticides on them to be washed with regular laundry. The pesticides can rub off on other items.

Cleaning Eyewear and Respirators
Hand-wash reusable respirator facepieces, goggles, face shields, and shielded safety glasses, following manufacturer's instructions. In general, use mild detergent and warm water to wash the items thoroughly. Rinse well. Wipe dry, or hang in a clean area to air dry.

Cleaning Other PPE
1. Follow the manufacturer's cleaning instructions. If the instructions say only to wash the item, or if there are no cleaning instructions, follow the procedure below.

2. Recommended procedure for washing most PPE:
a. **Rinse** in a washing machine or by hand.
b. **Wash in a washing machine**, using a heavy-duty detergent and hot water for the wash cycle.
c. **Wash only a few items at a time** to allow plenty of agitation and water for dilution. Use the highest water-level setting.
d. **Rinse twice** using two rinse cycles and warm water.
e. **Use two entire machine cycles** to wash items that are moderately to heavily contaminated.

f. **Run the washer through at least one more entire cycle** without clothing, using detergent and hot water, to clean the machine.
3. Some plastic or rubber items that are not flat, such as gloves, footwear, and coveralls, must be washed twice — once to clean the outside and a second time after turning the item inside out.

4. Some items, such as heavy-duty boots and rigid hats or helmets, should be washed by hand using hot water and heavy-duty detergent.

5. **Hang the items to dry**, if possible. Let them hang for at least 24 hours in an area with plenty of fresh air — preferably outdoors. Do not hang items in enclosed living areas.

6. You may **use a clothes dryer** for fabric items if it is not possible to hang them to dry. But after repeated use, the dryer may become contaminated with pesticides.

Note to Employers:
This fact sheet will help you comply with the section of the WPS that requires you to provide information to people (other than your own handlers) who clean or maintain you pesticide equipment. You are not required to give them this information in written form, but you may find that photocopying this fact sheet is an easy way to pass along the necessary information.

Working Safely with Pesticide Equipment
1. The equipment you will be cleaning, adjusting, or repairing may have pesticides on it. Although you may not be able to see or smell the pesticides, they can rub off on you when you touch the equipment.

2. If pesticides get on you, they can hurt you. They can:
• cause skin rashes or burns,
• go through your skin and into your body and make you ill,
• burn your eyes,
• make you ill if you get them in your mouth.

3. You should wear work clothing that protects your body from pesticide residues, such as long-sleeved shirts, long pants, shoes, and socks. If possible, avoid touching the parts of the equipment where the pesticide is most likely to be. Or, if practical for the job that you will be doing, consider wearing rubber or plastic gloves and an apron.

4. You should not let pesticides stay on your hands:
• Wash your hands as soon as you finish handling the equipment.
• Wash your hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
• Wash or shower with soap and water, shampoo your hair, and put on clean clothes after work.
• Wash work clothes that may have pesticides on them separately from other clothes before wearing them again.

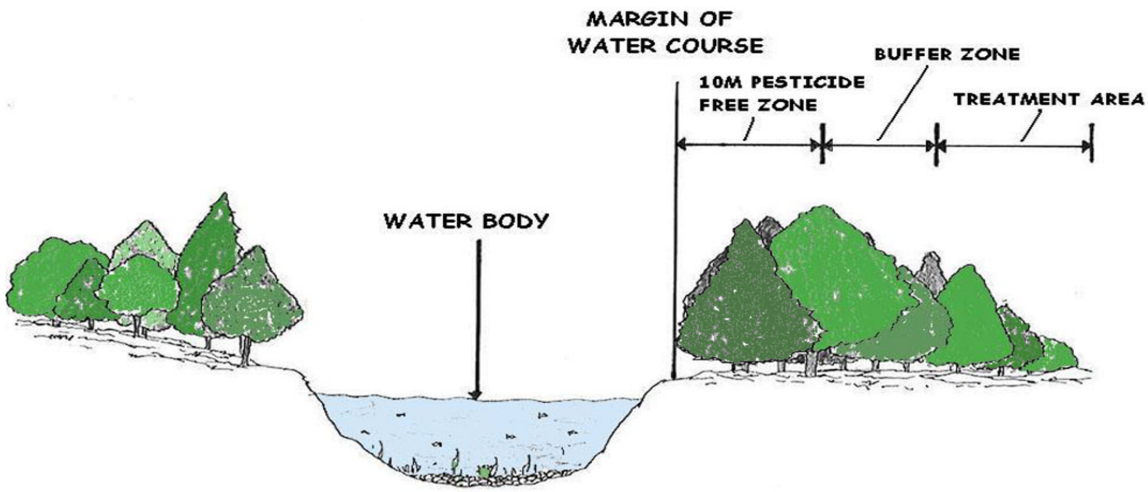
Master List

Applicator's Name	E.P.A. Certification Number

Pesticide Spill Kit
The pesticide spill kit shall contain the following:

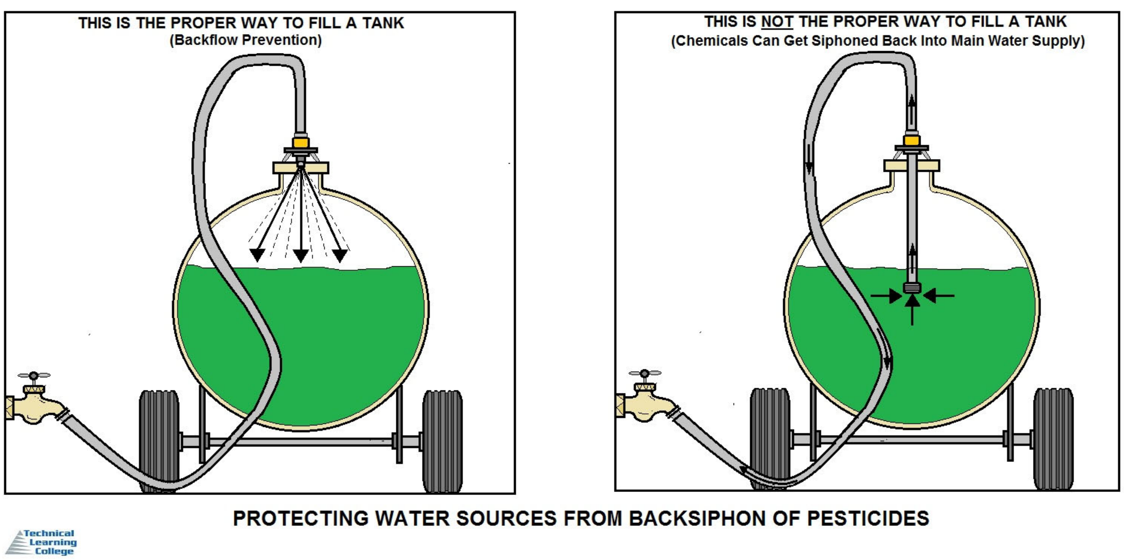
1 - 55-gallon open-head drum
1 - 50-pound bag of absorbent material
3 - 1-gallon jugs of household bleach
1 - 1-gallon jug of liquid detergent
1 - 24-inch push broom
1 - square point "D" handle shovel
1 - shop brush (dust pan brush)
1 - dust pan
12 - polyethylene bags w/ties

Whenever any of the above items are used, they shall be cleaned and/or replaced.



Streams and wetlands must be protected in the event of an accidental spill of any size. Even diluted chemicals pose a threat to natural habitats when released in large amounts.

Extra precautions must be taken when drawing water from streams or ponds.



PROTECTING WATER SOURCES FROM BACKSIPHON OF PESTICIDES

Antisiphoning devices must be used and be in good working order.

Tank mixes should be prepared at least ¼ mile from water resources. If this is not possible, make sure the ground at the mixing site does not slope toward the water, or construct an earthen dike to prevent pesticides from flowing into bodies of water or drains.

Recommended Considerations in Evaluating Pesticide Security

The security needs and critical control points will differ for every business and facility. However, some of the fundamental security control points include:

- **Securing Buildings, Manufacturing Facilities, Storage Areas, and Surrounding Property:** One of the most fundamental security needs is the prevention of intrusion to areas used to manufacture or store pesticides and other toxic chemicals. Elements of an effective security plan can range from basic fencing, lighting, and locks, to intrusion detection systems, cameras, and trained guards. For more information on basic tips on protecting your site, review the EPA's report "***A Chemical Accident Prevention: Site Security***" listed below in the section entitled ***"For More Information."***

- **Securing Pesticide Application Equipment and Vehicles:** Facilities and pesticide businesses should ensure that they have appropriate security protections to prevent intruder access to equipment used in mixing, loading, and applying pesticides. Before operating pesticide application tools and vehicles, handlers must have proper authorization and identification.

- **Aerial Application Equipment:** Security awareness is particularly important for large-scale pesticide application equipment like aircraft and large trucks. The FBI has requested that aerial applicators be vigilant to any suspicious activity relative to the use, training in, or acquisition of dangerous chemicals or airborne application of the same, including threats, unusual purchases, suspicious behavior by employees or customers, and unusual contacts with the public. Any suspicious circumstances or information should be reported to the FBI.

- **Protecting Confidential Information:** As business, safety, and security systems become more reliant on computer and communications technology, the need to secure these systems has grown. Such efforts include contingency planning for power losses, effective monitoring of access ports, adherence to password and backup procedures, and other mechanisms to maintain access for authorized personnel only.

- **Designing Facilities and Equipment to Minimize Risk of Damage:** Whether an intrusion to a computer by a hacker or a physical intrusion of your facility by a vandal or saboteur, it is important to take steps to minimize the extent of damage. For example, in order to prevent damage, the use of sturdy, reliable, and potentially blast-proof materials is essential in the construction of equipment used to transport and apply pesticides.

Developing Procedures and Policies that Support Security Needs:
Even the best hardware and staffing budgets are only as effective as the procedures and policies that control their use.

- Effective hiring and labor relations policies are important to obtain and retain good employees who will support and follow safety precautions. For example, the hiring process should ensure that pesticide handlers have all requisite training necessary to handle pesticides safely. Background checks of staff who have access to secure areas, particularly those areas where pesticides may be stored, are also necessary.

- Inventory management policies can help limit the amount of potentially hazardous pesticides stored on site, reducing the risks of accidental or intentional release or theft.

- Effective advance emergency response procedures can be critical, helping ensure that business officials and employees understand how to respond and whom to contact in the case of an emergency. Aside from accidents, such plans must also consider vandalism, bomb threats, and potential terrorist activity.

Pesticides Releases
The fate of pesticides released into the environment is unknown. Releases may be followed by a very complex series of events, which can transport the pesticide through the air or water, into the ground or even into living organisms. The medium for movement (air, water, soil, organisms) and the degree of movement (local or long distance distribution) will be different for each pesticide.

Pesticide Labeling Introduction

A handler employer or applicator must assure that handlers understand all of the labeling requirements related to safe use of pesticides before any handling activity takes place. The handler must also have access to the product labeling information during handling activities.

Safe Operation of Equipment
A handler employer must assure that handlers are instructed in the safe operation of all equipment they will be using.

It is the handler-employer's responsibility to assure that the equipment is working properly and to inform employees, when appropriate, that the equipment may be contaminated with pesticides and to explain the correct way to handle such equipment.

Personal Protective Equipment
Any person handling a pesticide must use the clothing and PPE specified on the label for product use. Characteristics of protective clothing and PPE are specified in the standard, as are exceptions to PPE specified on product labeling. The handler employer must take appropriate measures to prevent heat-related illnesses.

Decontamination
A handler employer must provide a decontamination site (as specified in the standard) for washing off pesticides and pesticide residues during any handling activity.

Emergency Assistance
A handler employer must provide the same emergency assistance to handlers as discussed for workers.

Implementation
The requirements of WPS was phased into effect back in 1992 and again in 2005. First, labeling requirements went into effect on April 21, 1993. Before that date, the EPA did not allow the statements required by the WPS to be on labels. The period back in October 22, 1992-April 21, 1993 allowed the EPA to inform registrants how to correctly revise their labels and to inform end-users about the label-specific requirements by which they must abide. The following label-specific requirements must appear on pesticide labels:

- ✓ PPE (must be worn, but the employer is not required to provide, clean, or maintain until after April 15, 1994) (EPA, 1993a),
- ✓ the REI, and,
- ✓ on some pesticide labels, a requirement to provide both oral warnings (location and description of treated area, REI, and not to enter during REI) and a treated area posting (at entrance to treated area) (EPA, 1992b and EPA, 1993a).

Pesticide Label Requirements

When these requirements appear on pesticide labels, all end-users must meet them unless exempt. Exempt end-users should voluntarily obey the requirements because of the dangers of pesticide exposure.

Second, beginning April 15, 1994, the generic requirements will be enforced. Generic requirements are intended to eliminate exposure to pesticides and to inform employees about the occupational hazards of pesticides. These require employers to make sure that employees are provided with:

- ✓ A display of information at a central location (WPS safety poster, the location of emergency medical facilities, and a list of recent pesticide applications).
- ✓ A decontamination facility.
- ✓ Pesticide safety training.
- ✓ Details of information exchanges between employers of agricultural workers and employers of commercial (for-hire) pesticide applicators.
- ✓ Notice about pesticide applications and information about pesticides used.
- ✓ Monitoring of handlers who are using highly toxic pesticides.
- ✓ Instruction on equipment safety, including inspection and maintenance.
- ✓ Instruction on the cleaning, inspection, and maintenance of PPE.
- ✓ Special instructions for handlers, including labeling information and safe operation of application equipment.
- ✓ Special application restrictions in nurseries and greenhouses.
- ✓ Emergency assistance when required (EPA, 1992a and EPA, 1993b).

Enforcement

States have primary enforcement responsibility for pesticide use violations if the Administrator of the EPA determines the State:
(1) has adopted adequate pesticide use laws and regulations;
(2) has adopted or is implementing adequate procedures for the enforcement of its laws and regulations; and
(3) has kept records and made reports showing compliance with (1) and (2) above, as the Administrator may require by regulation.

The Administrator of the EPA may also enter into cooperative agreements with States and Indian tribes to delegate the authority to cooperate in the enforcement of FIFRA.

Violations of the WPS carry both civil and criminal penalties.

Exceptions

Exceptions to the WPS are for pesticide application on an agricultural establishment in the following circumstances (**40 CFR**):

For mosquito abatement, Mediterranean fruit fly eradication, or similar wide-area public pest control programs sponsored by governmental entities.

On livestock or other animals, or in or about animal premises.

On plants grown for other than commercial or research purposes, which may include plants in habitations, home fruit and vegetable gardens, and home greenhouses.

On plants that are in ornamental gardens, parks, and public and private lawns and grounds that are only intended for aesthetic purposes or climatic modification.

By injection directly into agricultural plants. Direct injection does not include ***"hack and squirt,"*** "***frill and spray***," chemigation, soil-incorporation, or soil injection.

In a manner not directly related to the production of agricultural plants, including, but not limited to, structural pest control, control of vegetation along rights-of-way and in non-crop areas, and pastures and rangeland use.

For control of vertebrate pests.

As attractants or repellents in traps.

On the harvested portions of agricultural plants or on harvested timber.

For research uses of unregistered pesticides.

Exemptions
Exemptions from specific sections of the WPS apply only to owners of agricultural establishments and members of their immediate family while they are performing tasks related to the production of agricultural plants on their own agricultural establishments (40 CFR). These exemptions apply to the sections of the WPS covering the following:

Entry during a REI for short-term activities.

Entry during a REI for an agricultural emergency.

Entry during a REI for an EPA-granted exception.

Notice of application. Providing specific information about applications.

Pesticide safety training.

Posted pesticide safety information.

Decontamination and Emergency assistance.

Formulation Selection Considerations

The importance of formulation type is generally overlooked. The decision to use a formulation for a given application should include an analysis of the following factors:

- **Applicator safety**. Different formulations present various degrees of hazard to the applicator. Some products are easily inhaled, while others readily penetrate skin, or cause injury when splashed in the eyes.
- **Environmental concerns**. Special precautions need to be taken with formulations that are prone to drift in air or move off-target into water. Wildlife can also be affected to varying degrees by different formulations. Birds may be attracted by granules, and fish or aquatic invertebrates can prove especially sensitive to specific pesticide formulations such as 2,4-D esters.
- **Pest biology**. The growth habits and survival strategies of a pest will often determine what formulation provides optimum contact between the active ingredient and the pest.
- **Available application equipment.** Some pesticide formulations require specialized application equipment. This includes safety equipment, spill control equipment and, in special cases, containment structures.
- **Surfaces to be protected**. Applicators should be aware that certain formulations can stain fabrics, discolor linoleum, dissolve plastic, or burn foliage.
- **Cost**. Product prices may vary substantially, based on the active ingredients present and the complexity of delivering active ingredients in specific formulations.

Individuals such as commercial pest control technicians or farm workers who may not be involved in the selection process but are responsible for the actual application should also be made aware of the type of formulation they are using, its dangers and of the safety measures needed.

This choice of formulation type can have an impact on human health and the environment. Inattention to the type of formulation being used could mean the difference between a routine application and one that is the source of environmental contamination - or worse, a serious human exposure.

Pesticide Training Requirements and Resources

ALL of the WPS requirements in the revised final rule (Subparts D, E, F and G of 40 CFR Part 170) will become enforceable on January 2, 2017, **EXCEPT**:

- Including new content on pesticide safety information display (170.311(a)(3))
- Covering new content in worker and handler training (170.401(c)(3) and 170.501(c)(3))
- Suspension of applications by handlers if anyone is in the application exclusion zone (170.505(b)

The existing WPS regulations (subparts A, B and C of 40 CFR Part 170) will expire on and will no longer be effective after January 2, 2017.

Training Requirements
Beginning January 2, 2017, all workers and handlers are required to be trained on a yearly-basis. Before any worker or handler enters a pesticide-treated area on an agricultural establishment for any length of time, they need to receive the pesticide safety training (no grace period).

Under the revised WPS there will be no grandfathering of training that was acquired in 2016 or before.

- If a worker or handler was trained in 2016, they will need to receive WPS training within 1 year of the 2016 training. This training will not need to include the 2018 training content. For example, a worker trained on April 14, 2016 will need to be retrained prior to April 14, 2017.
- If a worker or handler was not trained in 2016, they would have to be trained before they do any worker or handler tasks.

To conduct safety training, you must be a certified applicator of restricted use pesticides, have completed a Train-the-Trainer program approved by EPA, or be an IDALS designated trainer. NOTE: After January 2, 2017, persons who have only been trained as WPS pesticide handlers will no longer be qualified to train workers.

Yearly training records for each handler and each worker must now be kept for 2 years. If a worker or handler requests those training records, you must provide it to them upon request.

The pesticide safety training for workers under the revised WPS (subparts D, E, F and G of 40 CFR Part 170) must be presented either orally from written materials or audio-visually, at a location that is reasonably free from distraction and conducive to training. All training materials must be EPA-approved. The training must be presented in a manner that the workers can understand, such as through a translator. The worker trainer must be present during the entire training program and must respond to workers' questions.

The training must include, at a minimum, all of the following after January 2, 2017:

- Where and in what form pesticides may be encountered during work activities.
- Hazards of pesticides resulting from toxicity and exposure, including acute and chronic effects, delayed effects, and sensitization.
- Routes through which pesticides can enter the body.
- Signs and symptoms of common types of pesticide poisoning.
- Emergency first aid for pesticide injuries or poisonings.

- How to obtain emergency medical care.
- Routine and emergency decontamination procedures, including emergency eye flushing techniques.
- Hazards from chemigation and drift.
- Hazards from pesticide residues on clothing.
- Warnings about taking pesticides or pesticide containers home.
- Requirements designed to reduce the risks of illness or injury resulting from workers' occupational exposure to pesticides, including application and entry restrictions, the design of the warning sign, posting of warning signs, oral warnings, the availability of specific information about applications, and the protection against retaliatory acts

Handler Training
The pesticide safety training for handlers under the revised WPS (subparts D, E, F and G of 40 CFR Part 170) must be presented either orally from written materials or audio-visually, at a location that is reasonably free from distraction and conducive to training. All training materials must be EPA-approved.

The training must be presented in a manner that the handlers can understand, such as through a translator. The handler trainer must be present during the entire training program and must respond to handlers' questions.

The training must include, at a minimum, all of the following after January 2, 2017:
- Format and meaning of information contained on pesticide labels and in labeling, including safety information such as precautionary statements about human health hazards.
- Hazards of pesticides resulting from toxicity and exposure, including acute and chronic effects, delayed effects, and sensitization.
- Routes by which pesticides can enter the body.
- Signs and symptoms of common types of pesticide poisoning.
- Emergency first aid for pesticide injuries or poisonings.
- How to obtain emergency medical care.
- Routine and emergency decontamination procedures.
- Need for and appropriate use of personal protective equipment.
- Prevention, recognition, and first aid treatment of heat-related illness.
- Safety requirements for handling, transporting, storing, and disposing of pesticides, including general procedures for spill cleanup.
- Environmental concerns such as drift, runoff, and wildlife hazards.
- Warnings about taking pesticides or pesticide containers home.

Requirements that must be followed by handler employers for the protection of handlers and other persons, including the prohibition against applying pesticides in a manner that will cause contact with workers or other persons, the requirement to use personal protective equipment, the provisions for training and decontamination, and the protection against retaliatory acts.

2018 Training Requirements and Resources and Beyond

The following requirements are enforceable January 2, 2018:

- Including new content on pesticide safety information display (170.311(a)(3))
- Covering new content in worker and handler training (170.401(c)(3) and 170.501(c)(3))
- Suspension of applications by handlers if anyone is in the application exclusion zone (170.505(b)

All other training requirements (Subparts D, E, F and G of 40 CFR Part 170) are the same as 2017.

Training Requirements
Starting January 2, 2018, workers and handlers will not be considered "trained" unless they have been trained according to the new training content requirements of the revised WPS rule (subparts D, E, F and G of 40 CFR Part 170).

Worker Training 2018
The pesticide safety training for workers under the revised WPS (subparts D, E, F and G of 40 CFR Part 170) must be presented either orally from written materials or audio-visually, at a location that is reasonably free from distraction and conducive to training. All training materials must be EPA-approved. The training must be presented in a manner that the workers can understand, such as through a translator. The worker trainer must be present during the entire training program and must respond to workers' questions.

The training must include, at a minimum, all of the following after January 2, 2018:

- The responsibility of agricultural employers to provide workers and handlers with information and protections designed to reduce work-related pesticide exposures and illnesses. This includes ensuring workers and handlers have been trained on pesticide safety, providing pesticide safety and application and hazard information, decontamination supplies and emergency medical assistance, and notifying workers of restrictions during applications and on entering pesticide treated areas. A worker or handler may designate in writing a representative to request access to pesticide application and hazard information.
- How to recognize and understand the meaning of the posted warning signs used for notifying workers of restrictions on entering pesticide treated areas on the establishment.
- How to follow directions and/or signs about keeping out of pesticide treated areas subject to a restricted-entry interval and application exclusion zones.
- Where and in what forms pesticides may be encountered during work activities, and potential sources of pesticide exposure on the agricultural establishment. This includes exposure to pesticide residues that may be on or in plants, soil, tractors, application and chemigation equipment, or used personal protective equipment, and that pesticides may drift through the air from nearby applications or be in irrigation water.
- Potential hazards from toxicity and exposure that pesticides present to workers and their families, including acute and chronic effects, delayed effects, and sensitization.
- Routes through which pesticides can enter the body.
- Signs and symptoms of common types of pesticide poisoning.
- Emergency first aid for pesticide injuries or poisonings.
- Routine and emergency decontamination procedures, including emergency eye flushing techniques, and if pesticides are spilled or sprayed on the body to use decontamination supplies to wash immediately or rinse off in the nearest clean water, including springs, streams, lakes or other sources if more readily available than

decontamination supplies, and as soon as possible, wash or shower with soap and water, shampoo hair, and change into clean clothes.

- How and when to obtain emergency medical care.
- When working in pesticide treated areas, wear work clothing that protects the body from pesticide residues and wash hands before eating, drinking, using chewing gum or tobacco, or using the toilet.
- Wash or shower with soap and water, shampoo hair, and change into clean clothes as soon as possible after working in pesticide treated areas.
- Potential hazards from pesticide residues on clothing.
- Wash work clothes before wearing them again and wash them separately from other clothes.
- Do not take pesticides or pesticide containers used at work to your home.
- Safety data sheets provide hazard, emergency medical treatment and other information about the pesticides used on the establishment they may come in contact with. The responsibility of agricultural employers to do all of the following:
    - Display safety data sheets for all pesticides used on the establishment.
    - Provide workers and handlers information about the location of the safety data sheets on the establishment.
    - Provide workers and handlers unimpeded access to safety data sheets during normal work hours.
- The rule prohibits agricultural employers from allowing or directing any worker to mix, load or apply pesticides or assist in the application of pesticides unless the worker has been trained as a handler.
- The responsibility of agricultural employers to provide specific information to workers before directing them to perform early-entry activities. Workers must be 18 years old to perform early-entry activities.
- Potential hazards to children and pregnant women from pesticide exposure.
- Keep children and nonworking family members away from pesticide treated areas.
- After working in pesticide treated areas, remove work boots or shoes before entering your home, and remove work clothes and wash or shower before physical contact with children or family members.
- How to report suspected pesticide use violations to the State or Tribal agency responsible for pesticide enforcement.
- The rule prohibits agricultural employers from intimidating, threatening, coercing, or discriminating against any worker or handler for complying with or attempting to comply with the requirements of this rule, or because the worker or handler provided, caused to be provided or is about to provide information to the employer or the EPA or its agents regarding conduct that the employee reasonably believes violates this part, and/or made a complaint, testified, assisted, or participated in any manner in an investigation, proceeding, or hearing concerning compliance with this rule.

Handler Training Information

We will examine these citations in detail later.

The pesticide safety training for handlers under the revised WPS (subparts D, E, F and G of 40 CFR Part 170) must be presented either orally from written materials or audio-visually, at a location that is reasonably free from distraction and conducive to training.

All training materials must be EPA-approved. The training must be presented in a manner that the handlers can understand, such as through a translator.

The handler trainer must be present during the entire training program and must respond to handlers' questions.

The training must include all of the training points/topics for workers PLUS the following after January 2, 2018:

- Information on proper application and use of pesticides.
- Handlers must follow the portions of the labeling applicable to the safe use of the pesticide.
- Format and meaning of information contained on pesticide labels and in labeling applicable to the safe use of the pesticide.
- Need for and appropriate use and removal of all personal protective equipment.
- How to recognize, prevent, and provide first aid treatment for heat-related illness.
- Safety requirements for handling, transporting, storing, and disposing of pesticides, including general procedures for spill cleanup.
- Environmental concerns, such as drift, runoff, and wildlife hazards.
- Handlers must not apply pesticides in a manner that results in contact with workers or other persons.
- The responsibility of handler employers to provide handlers with information and protections designed to reduce work-related pesticide exposures and illnesses. This includes providing, cleaning, maintaining, storing, and ensuring proper use of all required personal protective equipment; providing decontamination supplies; and providing specific information about pesticide use and labeling information.
- Handlers must suspend a pesticide application if workers or other persons are in the application exclusion zone.
- Handlers must be at least 18 years old.
- The responsibility of handler employers to ensure handlers have received respirator fit-testing, training and medical evaluation if they are required to wear a respirator by the product labeling.
- The responsibility of agricultural employers to post treated areas as required by this rule.

Handler Checklist

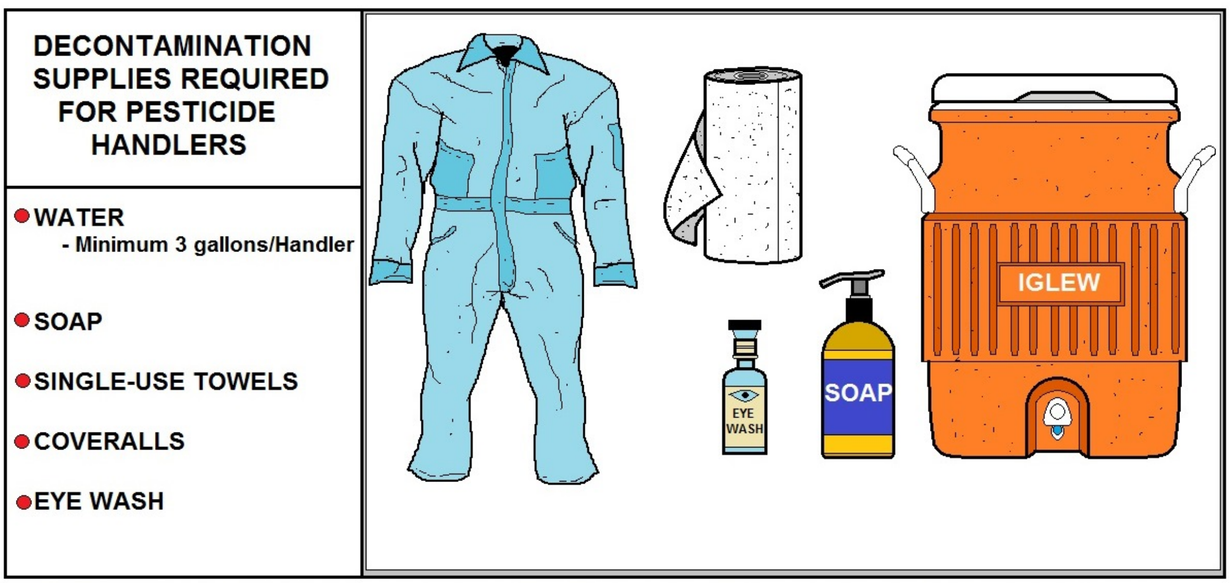
☐ Ensure handlers are a minimum of 18 years old.
☐ Complete WPS handler training before conducting handler tasks.
☐ Keep records of WPS handler training and provide record to handlers if requested.
☐ Display pesticide safety information at the central location and, if applicable, decontamination
locations.
☐ Display pesticide **application and hazard** information at the central location.
☐ Keep records of the pesticide application information and SDSs for 2 yrs.
☐ Provide establishment-specific information to handlers.
☐ Provide pesticide application information and SDSs on request of handler, medical personnel or designated representative.
☐ Provide handler with training/instruction on safe operation of pesticide equipment and all application equipment is inspected daily for leaks, etc. and repaired if necessary.
☐ Read to, or inform, handlers of pesticide label statements related to human hazards, first aid & safety, in a manner they can understand.
☐ Have pesticide label available to handler at all times during application.
☐ Provide tasks and instructions to handler supervisors to ensure compliance with WPS requirements.
☐ Ensure supervisors give directions to handlers for WPS compliance.
☐ Provide information (Information Exchange) to Commercial Pesticide Handler Employer (CPHE) (i.e., custom application or crop advisor).
☐ Ensure handlers do not work on pesticide equipment without receiving handler training. Ensure any individual not directly employed receives information on pesticides before using, cleaning, repairing, etc. pesticide equipment.
☐ Provide clean PPE in operating condition to handlers.
☐ Only exceptions to handler PPE are those allowed by WPS.
☐ Follow restrictions DURING applications to keep workers and other persons out of certain areas (treated area and AEZ or enclosed space production area).
☐ Follow other restrictions DURING applications (Do not contact workers or other persons directly or through drift; and applicator temporarily suspends the application if workers or other persons are in the AEZ or enclosed space production area).
☐ Monitor handler every 2 hours visually or by voice communication for applications of pesticides with skull & crossbones on label.
☐ Fumigant applications in enclosed space production facilities – have a second handler outside of the enclosed space to continuously monitor (voice or visual), or rescue the applicator if necessary. Must have second set of required PPE outside of application space.
☐ If a respirator is required, follow respirator requirements (i.e., medical evaluation, fit testing,
respirator training) and ensure that all records of completion of these tasks kept for 2 years.
☐ Provide decontamination supplies (and eye flushing supplies, if required) at required locations.
☐ Make emergency assistance available (information and transportation).

Pesticide Safety Training Review

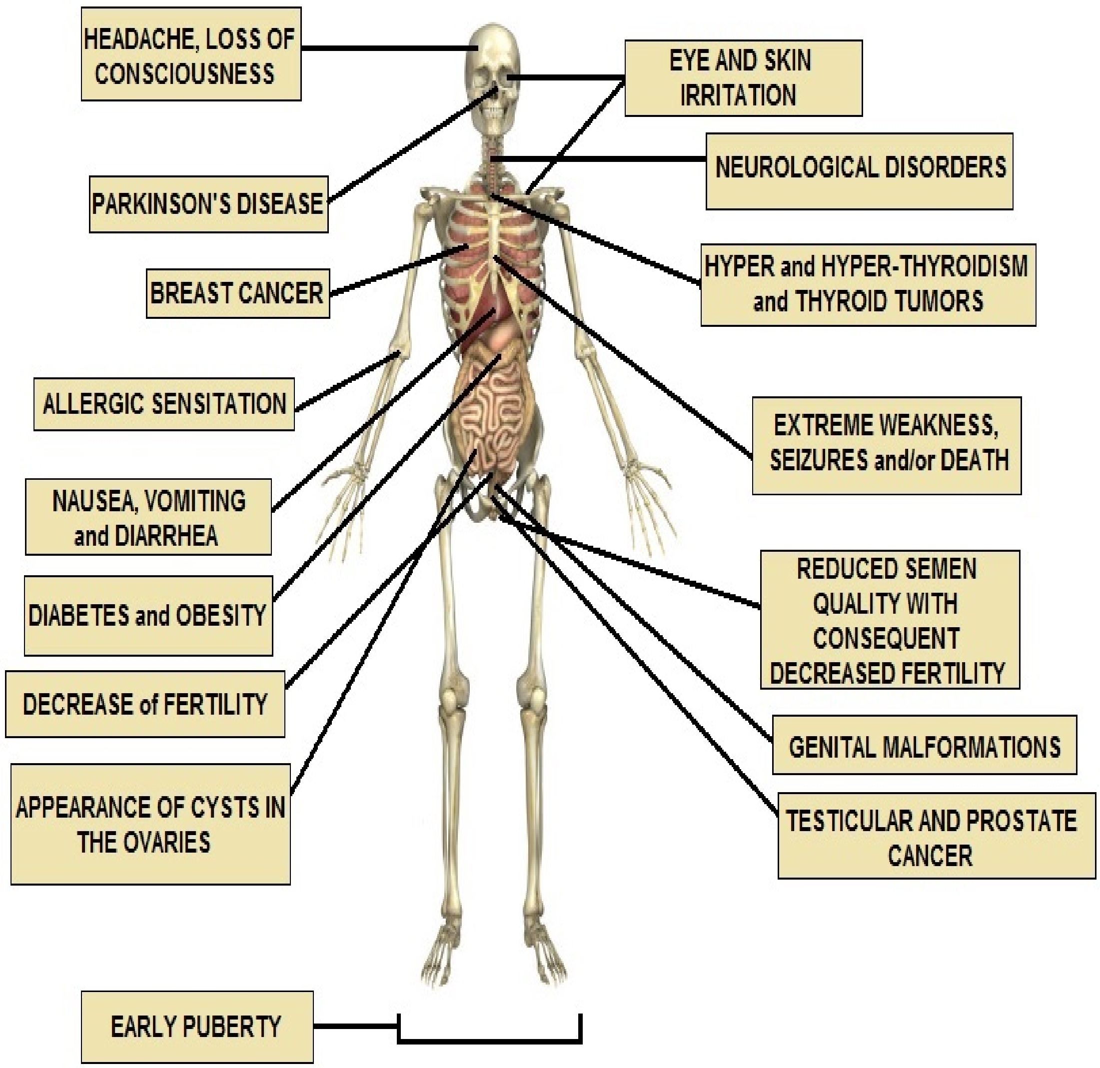
Ensure that **workers** are trained before performing tasks in a pesticide treated area (REI in effect within the last 30 days). 170.401 (a) Ensure that **handlers** are trained before performing any handler activity. 170.501 (a) There is no grace period for worker or handler training.

1. Train workers and handlers annually. 170.401 (a) and 170.501 (a)
2. Present training using EPA-approved materials either orally from written materials or audio-visually. After January 2, 2018, the training must cover additional topics. 170.401 (c) and 170.501 (c)
3. Trainers must be certified applicators or have completed an EPA-approved train-the-trainer program or be designated by the State or Tribal pesticide enforcement agency. 170.401 (c)(4) and 170.501 (c)(4)
4. Training must be delivered in a manner the employees can understand, and the trainer must be present and respond to questions. 170.401 (c)(1) and 170.501 (c)(1)
5. Maintain training records on the establishment for two years from the training date for each worker and handler required to be trained on the agricultural establishment. 170.401 (d) and 170.501 (d)

Separate from the pesticide safety training, employers must tell workers and handlers where to find the following on the worksite: EPA WPS safety poster (or equivalent), application information, SDSs and decontamination supplies. 170.403 and 170.503 (b).



DECONTAMINATION SUPPLIES REQUIRED FOR PESTICIDE HANDLERS (Must be located within 1/4 of a Mile of ALL Workers AND Handlers)



TOXIC IMPACT OF PESTICIDES ON HUMAN BODY

	GLOVES	HARD HAT	APRON	COVERALLS	RESPIRATOR	FOOTWEAR	PROTECTIVE EYEWEAR
MIXING / LOADING	CHEMICAL RESISTANT	NO	NO	YES + LONG SLEEVED SHIRT / LONG PANTS	NO	SHOES + SOCKS	NO
ENCLOSED CAB	NO	NO	NO	NO	NO	SHOES + SOCKS	NO
OPEN CAB	CHEMICAL RESISTANT	NO	NO	YES + LONG SLEEVED SHIRT / LONG PANTS	NO	SHOES + SOCKS	NO
CLEANOUT	CHEMICAL RESISTANT	NO	NO	YES + LONG SLEEVED SHIRT / LONG PANTS	NO	SHOES + SOCKS	NO

PESTICIDE HANDLING SAFETY REFERENCE (PPE)

Decontamination Supply Information

1. Establish accessible decontamination supplies located together within 1/4 mile of all **workers**
(when required 170.411 (c)) and **handlers**. 170.411 and 170.509
- 1 gallon of water per worker and 3 gallons of water per handler at the beginning of each work period for routine and emergency decontamination,
- Plenty of soap and single-use towels, Note: hand sanitizers and wet towelettes are insufficient. 170.411 (b)(2) and 170.509 (b)(2)
- A clean coverall (or other clean change of clothes) for handlers

2. Provide water that is safe and cool enough for washing, eye-flushing, and drinking. Do not use water that is also used for mixing pesticides unless steps are taken to ensure safety. 170.411 (b)(1)
3. Provide **handlers** with decontamination supplies where personal protective equipment (PPE)
is removed at the end of a task. 170.509 (a)
4. Provide **handlers** with decontamination supplies at each mixing and loading site. 170.509 (c)(1)
5. When a product requires protective eyewear for **handlers**, and/or when using a closed system under pressure, provide the following in mixing and loading areas: a system that can deliver gently running water at 0.4 gallons per minute for at least 15 minutes or 6 gallons of water in containers suitable for providing a gentle eye-flush for about 15 minutes. 170.509 (d)(1)
6. When applying a product that requires protective eyewear, provide 1 pint of water per **handler** in portable containers that are immediately available to each handler. 170.509 (d)(2)
7. Do not put **worker** decontamination supplies in areas being treated or under an REI. 170.411 (d)
8. For **handlers**, decontamination supplies must be kept outside the treated area, or any area under an REI, unless they are protected from contamination in closed containers. 170.509 (c)(1)&(3)

Employer Information Exchange

1. Before any application, commercial pesticide handler employers must make sure the owner/
operator of an agricultural establishment where a pesticide will be applied, is aware of:
- Location and description of area to be treated,
- Date of application, estimated start time and estimated end time of the application,
- Product name, EPA registration number, active ingredient(s), and REI,
- Whether the product label requires both oral warnings and treated area posting,
- All other safety requirements on labeling for workers or other people. 170.313 (i)

2. Owners/operators of agricultural establishments must make sure any commercial pesticide
- handler employer they hire is aware of: Specific location and description of any treated areas where an REI is in effect that the commercial handler may be in or walk within 1/4 mile of, and,
- Restrictions on entering those areas. 170.309 (k)
- The commercial pesticide employer must pass this information along to the handler doing the work. 170.313 (h)

Emergency Assistance

If there is reason to believe a worker or handler has been exposed to pesticides, during or within 72 hours of employment, and needs emergency medical treatment, employers must do the following:

1. Promptly make transportation available to an appropriate emergency medical facility.
2. Promptly provide to the treating medical personnel, information related to each pesticide product to which the person may have been exposed:

- Safety Data Sheet
- Product name, EPA registration number, and active ingredient(s).
- Description of how the pesticide was used on the agricultural establishment.
- Circumstances that could have resulted in exposure to the pesticide. 170.309 (f)

Additional Duties for Worker Employees

These requirements apply to agricultural employers who employ workers.

Restrictions During Applications 170.405 (a)-(b)

During pesticide applications, keep workers and everyone other than appropriately trained and equipped handlers out of the treated area (for all types of applications) and out of:

- The application exclusion zone (AEZ) for outdoor production, or
- A specified area that varies by the type of application until the ventilation criteria are met for enclosed space production.

0 - 4 Hours	4 - 12 Hours	12 - 24 Hours	24 + Hours
DO NOT ENTER	EARLY RE-ENTRY BY A CERTIFIED FARMER	EARLY RE-ENTRY BY WORKERS	ALL ENTRY
- THE END OF THE APPLICATION IS THE START OF THE 24-Hour RESTRICTED ENTRY INTERVAL - NO ONE MAY ENTER THE TREATED AREA	- MUST NOT DO ANY LABOR TASKS - MUST ONLY BE THE AREA FOR LESS THAN 24 - Hours - MUST WEAR THE PROTECTIVE CLOTHING AND PPE STATED ON THE LABEL FOR MIXING PLUS WEAR: NIOSH-APPROVED RESPIRATOR	- MUST NOT DO ANY LABOR TASKS - CANNOT CONTACT ANY SURFACES THAT MAY HAVE RESIDUES - MUST WEAR THE PROTECTIVE CLOTHING AND PPE ITEMS IF THEY ARE STATED ON THE LABEL FOR EARLY RE-ENTRY	- END OF REI ONLY ON A LABEL WITH A RE-ENTRY FROM 24 Hours TO SEVERAL DAYS - EVERYONE MAY ENTER

EXAMPLE OF AN REI (Restricted Entry Interval) FROM A PESTICIDE LABEL

Restricted-Entry Intervals (REIs) 170.309 (I) and 170.407

Do not direct or allow any worker to enter or remain in the treated area until the REI has expired and all posted warning signs are removed or covered. Read the exceptions in 170.603.

Notice About Applications 170.409 (a)
1. Orally warn workers **and** post treated areas if required by the pesticide labeling.
2. If not, post warning signs if the REI is **greater than**:
- 48 hours for outdoor production or
- 4 hours for enclosed space production.

3. For all other applications, **either** orally warn workers or post warning signs.

RESTRICTED ENTRY INTERVAL (REI)

- TIME THAT MUST BE PASSED BEFORE ENTRY CAN BE MADE WITHOUT PPE
- PESTICIDE LABEL STATES DURATION
- MOST REI's ARE 4 Or 12 Hours
- DURATION CAN BE LONGER FOR CERTAIN PESTICIDES
- WARNING SIGNS CANNOT BE REMOVED UNTIL REI HAS EXPIRED

The responsibility of agricultural employers to post treated areas as required by this rule.

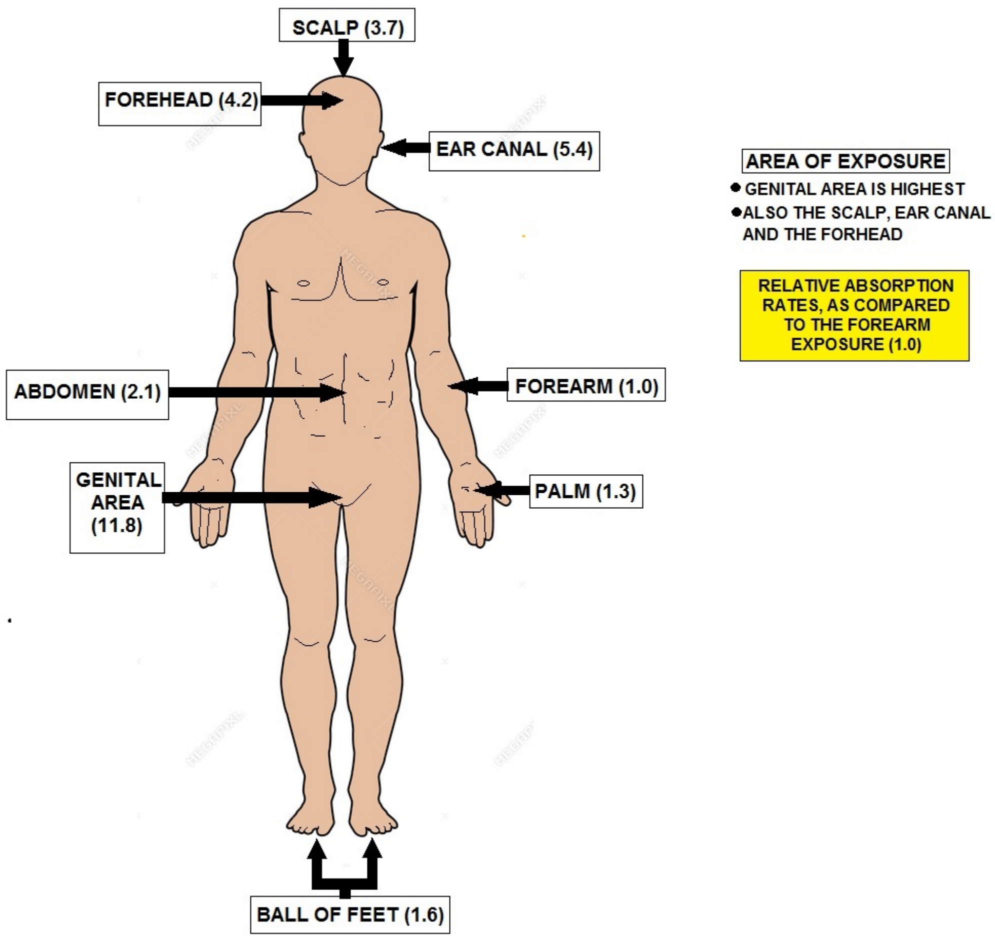
Posted Warning Signs 170.409 (b)
1. Post legible 14” x 16” WPS-design warning signs no more than 24 hours prior to an application; keep posted during REI; remove or cover before workers enter and within 3 days after the end of the REI. 170.409 (b)(1)-(3)
2. Post signs so they can be seen at all reasonably expected entrances to treated areas. 170.409 (b)(3)(ii)
3. Warning signs can be smaller than 14” x 16” under certain conditions. All warning signs must meet specific requirements. 170.409 (b)

Oral Warnings 170.409 (c)
1. Before each application, tell workers who are on the establishment (in a manner they can understand):
- Location and description of treated area,
- Date and times entry is restricted
- AEZ, REI, and not to enter during REI.

2. Workers who enter the establishment after application starts must receive the same warning at the start of their work period.

Additional Duties for Agricultural Employers Duties
Before allowing persons not directly employed by the establishment to clean, repair, or adjust pesticide application equipment, provide the following information:

➢ The equipment may be contaminated with pesticides.
➢ The potentially harmful effects of pesticide exposure.
➢ How to handle equipment to limit exposure to pesticides.
➢ How to wash themselves and/or their clothes to remove and prevent exposure to pesticide residues. 170.309 (g) and 170.313 (l)



ABSORPTION RATES OF PESTICIDE EXPOSURE

Application Restrictions and Monitoring 170.505

1. Do not allow handlers to apply a pesticide so that it contacts, directly or through drift, anyone other than appropriately trained and equipped handlers.
2. Handlers must suspend applications when anyone other than appropriately trained and equipped handlers enter the application exclusion zone (AEZ). This goes into effect on January 2, 2018. 170.505 (b)
3. When anyone is handling a highly toxic pesticide with a skull and crossbones, maintain sight or voice contact every two hours.
4. Make sure a trained handler equipped with labeling-specific PPE maintains constant voice or visual contact with any handler in an enclosed-space production site (e.g., greenhouses, high tunnels, indoor grow houses) while applying a fumigant.

Specific Instructions for Handlers

1. Before handlers do any handling task, inform them, in a manner they can understand, of all pesticide labeling instructions for safe use. 170.503 (a)(1)
2. Ensure that the handler has access to product labeling during the entire handling task. 170.503 (a)(2)

Equipment Safety

1. Inspect pesticide handling equipment before each day of use, and repair or replace as needed. 170.309 (j) and 170.313 (g)
2. Allow only appropriately trained and equipped handlers to repair, clean, or adjust pesticide equipment that contains pesticides or residues, unless they are not employed on the establishment.

170.309 (g) and 170.507 (a) See Additional Agricultural Employer

Personal Protective Equipment (PPE) Handlers Must Use

1. Provide handlers with the PPE required by the pesticide labeling, and be sure it is: 170.507 (b)
   - Clean and in operating condition, 170.507 (b)
   - Worn and used according to the manufacturer's instructions,170.507 (c)
   - Inspected before each day of use, 170.507 (c)(2)
   - Repaired or replaced as needed. 170.507 (c)(2)
2. When a respirator is required by product labeling, provide handlers with:
   - A medical evaluation to ensure the handler is physically able to safely wear the respirator,
   - Training in respirator use, and
   - A fit test to ensure the respirator fits correctly.
   - Keep records on the establishment of these items for two years. 170.507 (b)(10)
3. Take steps to avoid heat-related illness when labeling requires the use of PPE for a handler activity. 170.507 (e)
4. Provide handlers a pesticide-free area for:
   - Storing personal clothing not in use,
   - Putting on PPE at start of task,
   - Taking off PPE at end of task. 170.507 (d)(9)
5. Do not allow used PPE to be taken home. 170.507 (d)(10)

Care of PPE

1. Store and wash used PPE separately from other clothing and laundry. 170.507 (d)(3)
2. If PPE will be reused, clean it before each day of reuse, according to the instructions from the PPE manufacturer unless the pesticide labeling specifies other requirements. If there are no other instructions, wash in detergent and hot water. 170.507 (d)(1)
3. Dry the clean PPE before storing. 170.507 (d)(4)
4. Store clean PPE away from personal clothing and apart from pesticide-contaminated areas. 170.507 (d)(5)

CARTRIDGE COLOR CODE	COLOR	USED TO PROTECT AGAINST
	BLACK	ORGANIC VAPORS (PESTICIDES) and PAINT SPRAYING
	GREEN	AMMONIA: ANHYDROUS or FROM LIVESTOCK CONFINEMENT
	YELLOW	ACID GASES (i.e: HYDROGEN SULFIDE (H_2S) or CARBON DIOXIDE (CO_2))
	OLIVE	ORGANIC VAPORS, AMMONIA and ACID GASES
	PINK	WELDING FUMES AND DUSTS

CHART SHOWING RESPIRATOR CARTRIDGES THAT CAN BE USED IN PESTICIDE APPLICATIONS
(Color Coding to show specific use)

Replacing Respirator Purifying Elements

1. Replace particulate filters or filtering facepiece respirators when any following condition is met:
- ➢ When breathing becomes difficult,
- ➢ When the filter is damaged or torn,
- ➢ When the respirator label or pesticide label requires it,
- ➢ After 8 total hours of use, in the absence of any other instructions or indications of service life. 170.507 (d)(6)

2. Replace vapor-removing cartridges/canisters when any following condition is met:
- ➢ When odor/taste/irritation is noticed,
- ➢ When the respirator label or pesticide label requires it (whichever is shorter),
- ➢ When breathing resistance becomes excessive,
- ➢ After 8 total hours of use, in the absence of any other instructions or indications of service life. 170.507 (d)(7)

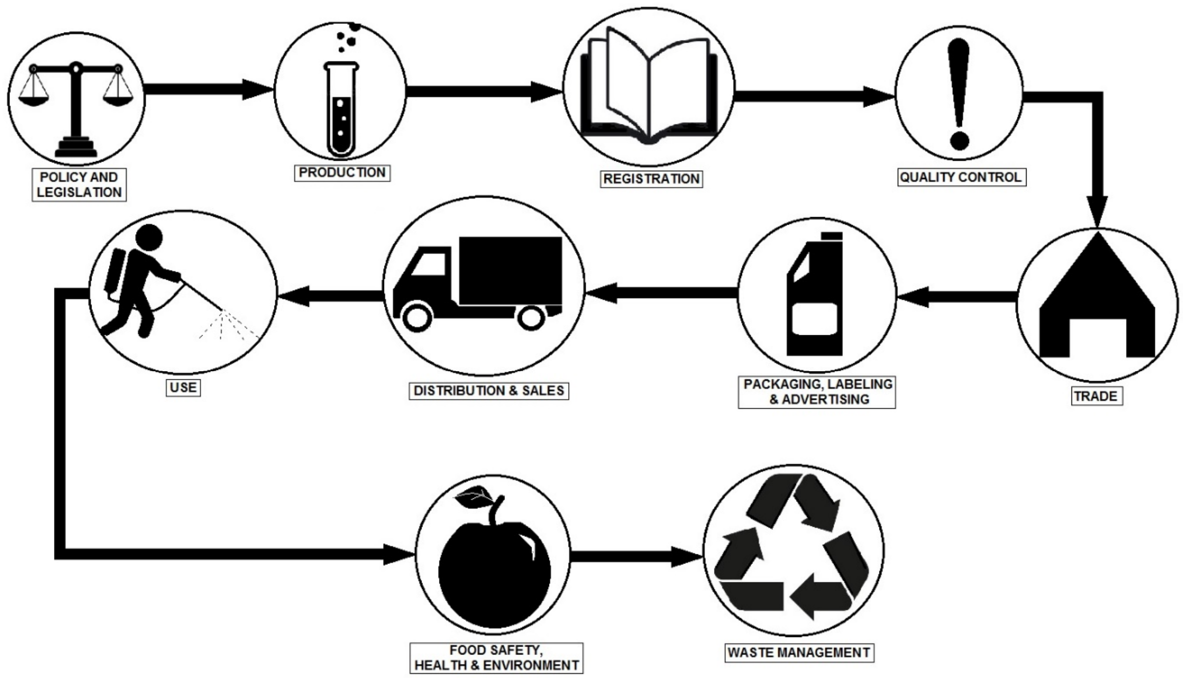
Disposal of PPE

1. Discard, do not clean, coveralls and other absorbent materials that are heavily contaminated with pesticide having a signal word “DANGER” or “WARNING.” When discarding PPE, ensure that it is unusable as apparel or made unavailable for further use.
2. Follow federal, state, and local laws when disposing of PPE that cannot be cleaned correctly. 170.507 (d)(2)

Instructions for People Who Clean PPE 170.507 (d)(8)

The handler employer must inform people who clean or launder PPE:

- That PPE may be contaminated with pesticides,
- Of the potential for harmful effects of exposure to pesticides,
- How to protect themselves when handling PPE,
- How to clean PPE correctly, and
- Decontamination procedures to follow after handling contaminated PPE.



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PESTICIDE MANAGEMENT (New & Current)

This course contains EPA’s federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA’s regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

CHEMICAL SPILL / EMERGENCY RESPONSE

TYPE OF SPILL	EXAMPLES OF FLUID	RECOMMENDED SPILL KIT
HYDROCARBON SPILLS	• OILS • FUELS • SOLVENTS • HYDRAULIC FLUIDS	OIL & FUEL SPILL KIT
WATER - BASED LIQUIDS OR NON-HAZARDOUS CHEMICALS	• COOLANTS • HERBICIDES & PESTICIDES • DEGREASERS • PAINTS • BEVERAGES	GENERAL PURPOSE SPILL KIT
HAZARDOUS CHEMICALS (CAUTION HAZARDOUS CHEMICALS)	• ACIDS • ALKALIS • CAUSTICS • CORROSIVE LIQUIDS	CHEMICAL SPILL KIT

CHEMICAL SPILL CLEAN-UP CRITERIA

Quick Reference Guide WPS 2017-2018 Section

The WPS is a federal regulation designed to protect agricultural workers (people employed in the production of agricultural plants) and pesticide handlers (people mixing, loading, or applying pesticides or doing certain tasks involving direct contact with pesticides).

Each section links to the Code of Federal Regulations (40 CFR Part 170) for more information on the revised WPS. (www.ecfr.gov)

The section summarizes the maximum requirements under the revised WPS. It does not include exemptions and exceptions that may allow you to do less.

See the referenced sections below.
Exemptions (general) 170.303 (b) and170.601
Exceptions for **workers** 170.401 (b) and 170.409 (a)(2)
Exceptions for early-entry **workers** during a restricted-entry interval 170.603
Exceptions for **handlers** 170.501 (b)
Exceptions to PPE required on pesticide labels 170.607

Employer Responsibilities for Supervisors and Labor Contractors
Employers must provide sufficient information to supervisors and/or labor contractors to ensure compliance with the revised WPS.

Specify:
✓ The tasks supervisors / labor contractors must do, and
✓ The information they must provide to workers/handlers.

Employers are liable for a penalty under FIFRA if a supervisor or labor contractor acting for them fails to comply with the revised WPS requirements. 170.309 (d), 170.313 (d), 170.317 (c)

Duties of All Employees
These requirements apply to agricultural employers and commercial pesticide handler employers except the pesticide safety, application and hazard information requirements apply only to agricultural employers.

Anti-Retaliation
Employers must not retaliate against a worker or handler who attempts to comply with the WPS, files a complaint, or provides information in an investigation of alleged WPS noncompliance. 170.315

Minimum Age Requirements
1. Ensure that early-entry workers and all handlers are at least 18 years old. 170.309 (c) and 170.313 (c)

Integrated Pest Management Summary

Integrated pest management (IPM) is the control strategy of choice for homeowners, growers, and commercial applicators.

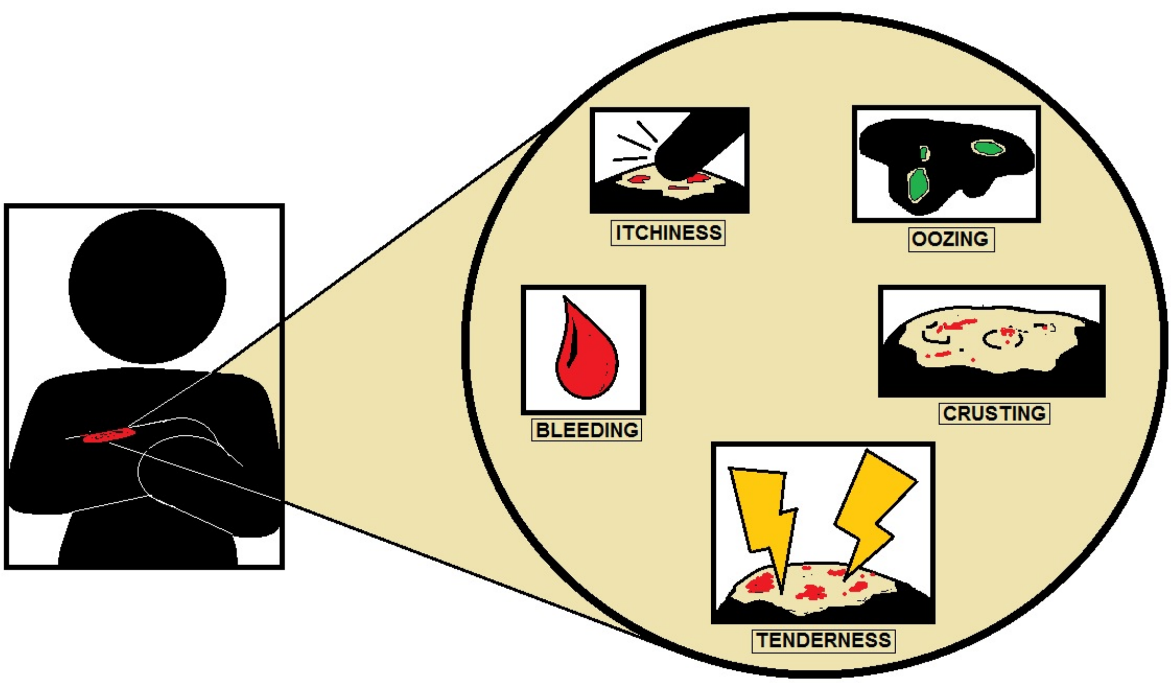
IPM is an approach to pest management that blends all available management techniques - nonchemical and chemical - into one strategy: Monitor pest problems, use nonchemical pest control, and resort to pesticides **only** when pest damage exceeds an economic or aesthetic threshold.

Labels and regulations change and new products are introduced routinely. Therefore, the pesticide selection process should be conducted just prior to **each** growing season.

The selection of a pesticide requires planning and knowledge of the alternatives. Begin by developing a comprehensive list of available pesticides for a specific crop, turf, or home garden pest.

Pesticide recommendations for controlling any insect, weed, or disease can be suggested by numerous sources: the Cooperative Extension Service; consultants; agrichemical and urban pesticide dealers; product manufacturers; garden and nursery centers; association newsletters; trade journals; and expert applicators.

After developing a pesticide list, the user should obtain labels of all products under consideration so that their strengths and weaknesses can be analyzed on a product profile worksheet. Labels generally are available locally from retail outlets or their suppliers.



SYMPTOMS OF BOWENS DISEASE
(Caused from Crop Dusting using Arsenic Powders)

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Pesticide Section Post Quiz

Internet Link to Assignment…
http://www.abctlc.com/downloads/PDF/AdvancedPestASS.pdf

Identify the term for each statement.

1. Substances (excluding fertilizers or other plant nutrients) that alter the expected growth, flowering, or reproduction rate of plants.

2. Kill insects and other arthropods.

3. Microorganisms that kill, inhibit, or out compete pests, including insects or other microorganisms.

4. Kill or inactivate disease-producing microorganisms on inanimate objects.

5. Kill or repel organisms that attach to underwater surfaces, such as boat bottoms.

6. Kill microorganisms (such as bacteria and viruses).

7. Promote drying of living tissues, such as unwanted plant tops.

8. Disrupt the molting, maturity from pupal stage to adult or other life processes of insects.

9. Kill nematodes (microscopic, worm-like organisms that feed on plant roots).

10. Repel pests, including insects (such as mosquitoes) and birds.

Answers

1. Plant growth regulators, 2. Insecticides, 3. Microbial pesticides, 4. Disinfectants and sanitizers, 5. Antifouling agents, 6. Antimicrobials, 7. Desiccants, 8. Insect growth regulators, 9. Nematicides, 10. Repellents

.

Topic 2- EPA Required Training Citation Section

Section Focus: You will learn the basics Worker Protection Standard. At the end of this section, you will be able to describe EPA Worker Protection Standard. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

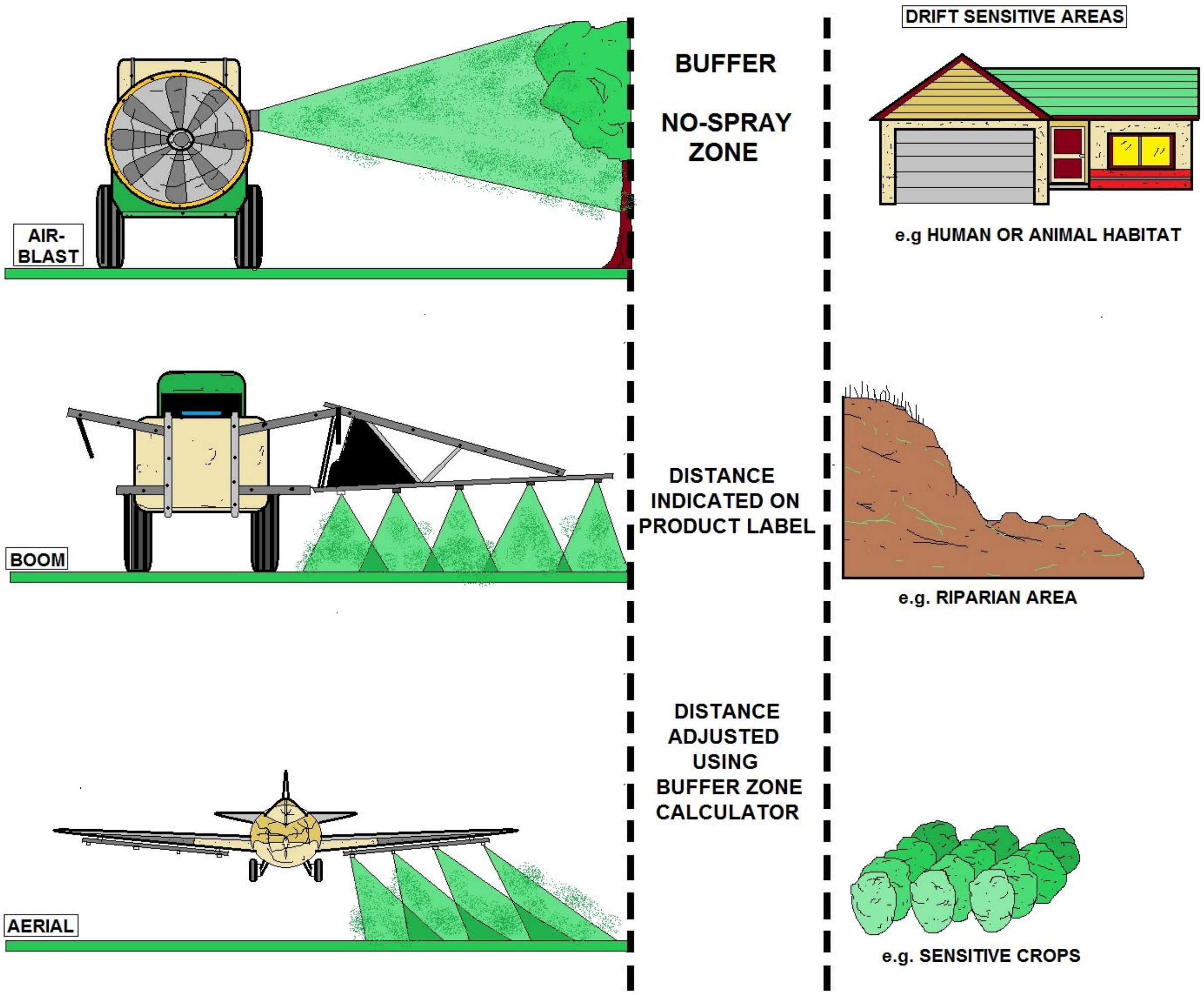
Scope/Background: EPA's Agricultural Worker Protection Standard (WPS) aims to reduce pesticide poisonings and injuries among agricultural workers and pesticide handlers. The WPS offers occupational protections to over 2 million agricultural workers and pesticide handlers who work at over 600,000 agricultural establishments. In 2015, EPA revised the WPS to decrease pesticide exposure incidents among farmworkers and their family members.

WPS Responsibility Citation 1.a.-1.g.

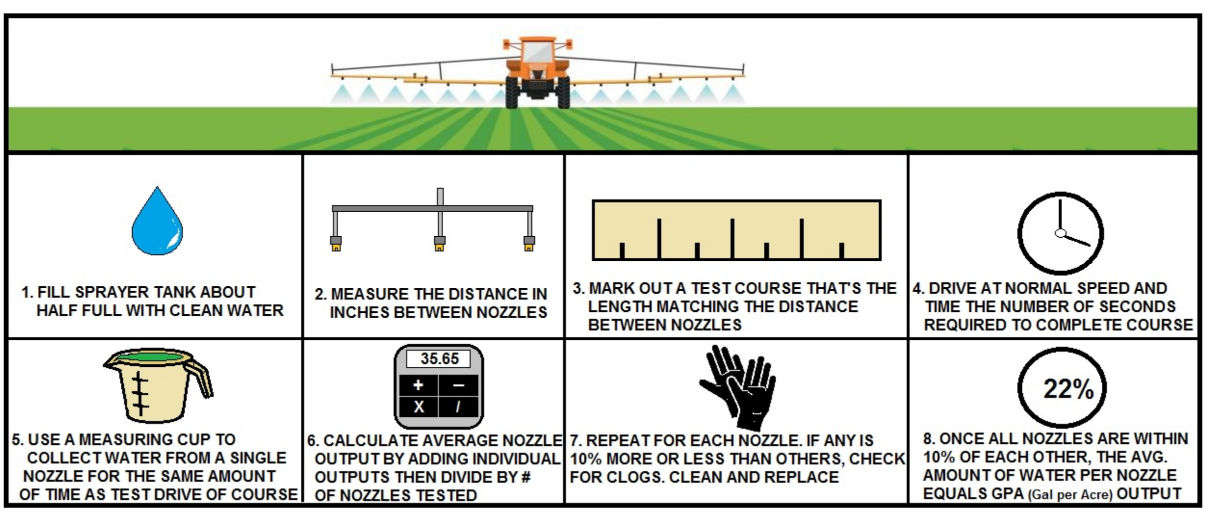
The responsibility of agricultural employers to provide workers and handlers with information and protections designed to reduce work-related pesticide exposures and illnesses.

This includes ensuring workers and handlers have been trained on pesticide safety, providing pesticide safety and application and hazard information, decontamination supplies and emergency medical assistance, and notifying workers of restrictions during applications and on entering pesticide treated areas.

A worker or handler may designate in writing a representative to request access to pesticide application and hazard information.



PESTICIDE APPLICATION METHODS



BOOM SPRAYER INSPECTION / CALIBRATION

Agricultural Employers Responsibility Citation 1.a.

All workers and handlers must be trained on pesticide safety before they begin working at your grow operation. The training can be presented orally from written materials or by video (Check with your State agency to ensure this section is acceptable). In either case, the training must be in a language that the workers and handlers understand. You may use a translator such as a bilingual employee if necessary.

The trainer (and translator if used) must be available to answer any questions by the employees during the training. Workers and handlers must be trained every five years (required annually since January 2017).

Training must be provided by a qualified WPS trainer. The best way for agricultural employers to comply with the training requirements is to either become qualified as a trainer, or have one or more of their employees qualified. Then new employees can be trained when they begin work, and maintain training annually thereafter.

Commercial Pesticide Applicators
Commercial (custom) pesticide applicators must provide certain information about the pesticide(s) to the owner/operator of a farm, forest, nursery, or greenhouse who hires them before their pesticides are applied on the agricultural establishment.

Information for Agricultural Establishment Operators
Commercial pesticide applicators must inform the operator of a farm, forest, nursery, or greenhouse about the following information:

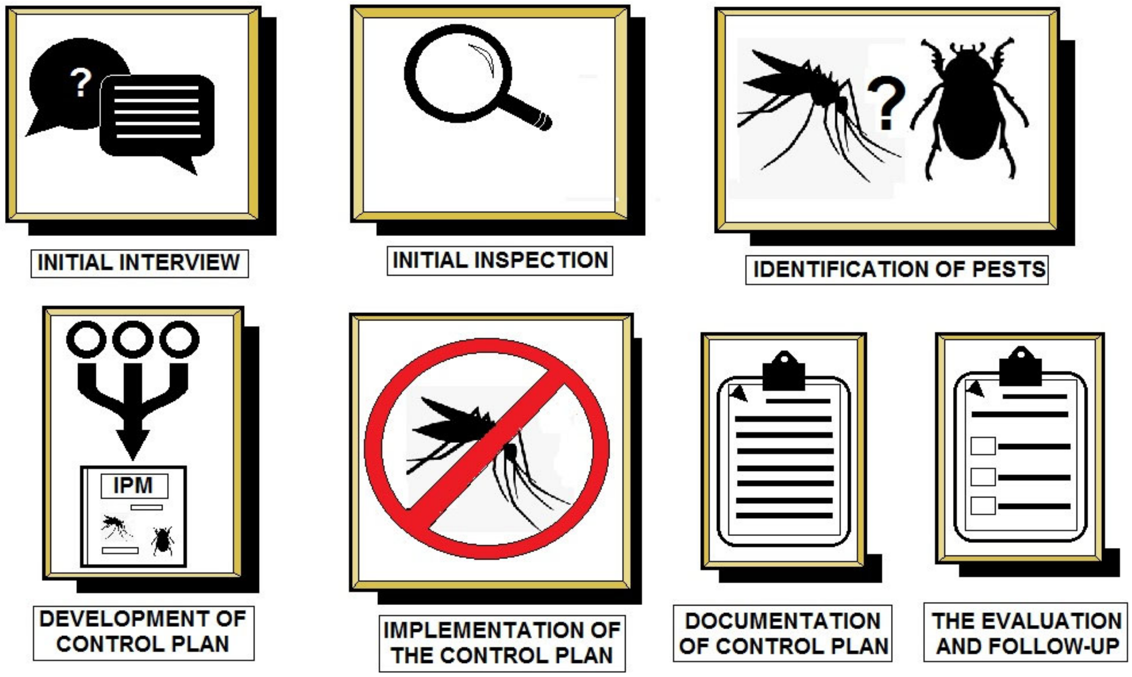
1. The specific location and description of the areas on the agricultural establishment that are to be treated with the pesticide(s)
2. The time and date the pesticide is scheduled to be applied
3. The product name, EPA registration number, and active ingredient(s) of the pesticide
4. The REI for the pesticide
5. The product's requirements regarding both treated-area postings and oral notifications
6. Any other specific requirements on the pesticide label concerning protection of workers and other persons during or after application

Operators of agricultural establishments must have this information to protect their employees. Operators of farms, forests, nurseries, and greenhouses must also provide commercial pesticide applicators with certain information concerning previously treated areas on the agricultural establishment.

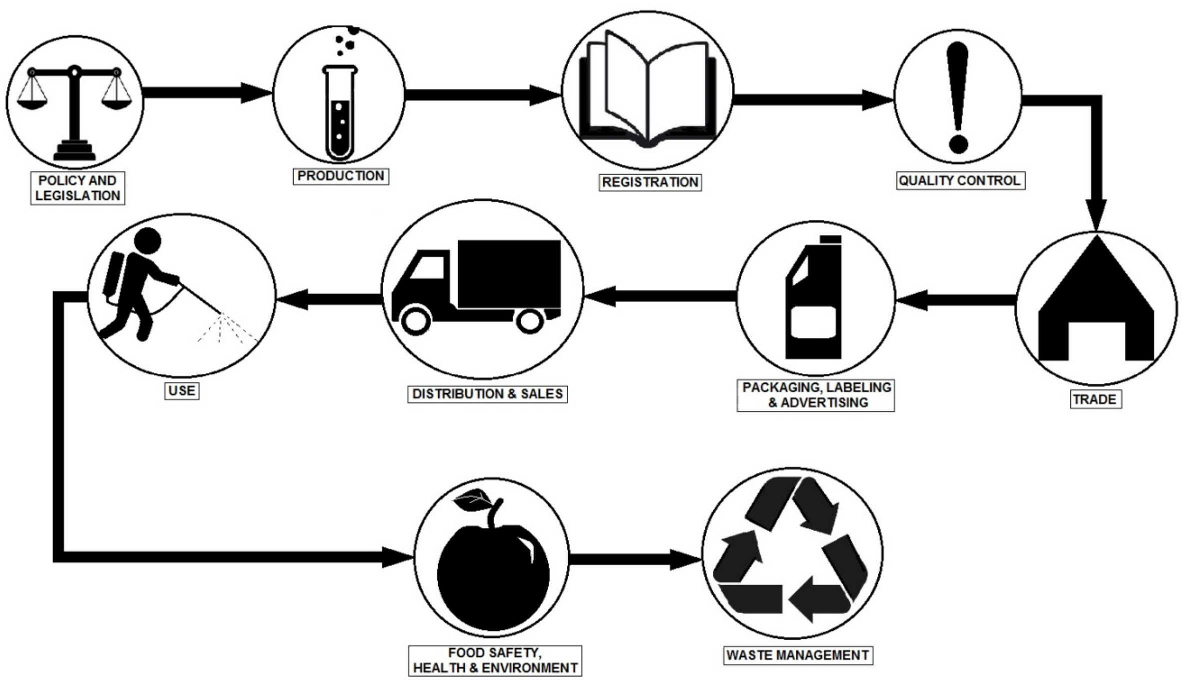
This information must include the following:

1. The specific location and description of all areas on the agricultural establishment that:
    - May be treated with a pesticide or be under a REI while the commercial applicator will be there
    - Are within ¼ mile of the applicator
    - Have entry restrictions

Operators of commercial pesticide applicator establishments must have this information to inform and protect their employees.



DEVELOPING AN INTEGRATED PESTICIDE MANAGEMENT PROGRAM (IPM)



PESTICIDE MANAGEMENT (New & Current)

§170.7 General Duties and Prohibited Actions

(a) *General duties.* The agricultural employer or the handler employer, as appropriate, shall:

(1) Assure that each worker subject to subpart B of this part or each handler subject to subpart C of this part receives the protections required by this part.

(2) Assure that any pesticide to which subpart C of this part applies is used in a manner consistent with the labeling of the pesticide, including the requirements of this part.

(3) Provide, to each person who supervises any worker or handler, information and directions sufficient to assure that each worker or handler receives the protections required by this part. Such information and directions shall specify which persons are responsible for actions required to comply with this part.

(4) Require each person who supervises any worker or handler to assure compliance by the worker or handler with the provisions of this part and to assure that the worker or handler receives the protections required by this part.

(b) *Prohibited actions.* The agricultural employer or the handler employer shall not take any retaliatory action for attempts to comply with this part or any action having the effect of preventing or discouraging any worker or handler from complying or attempting to comply with any requirement of this part.

§170.9 Violations of this Part

(a) Under the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. 136 *et seq.*) (FIFRA) section 12(a)(2)(G) it is unlawful for any person “to use any registered pesticide in a manner inconsistent with its labeling.” When this part is referenced on a label, users must comply with all of its requirements except those that are inconsistent with product-specific instructions on the labeling. For the purposes of this part, EPA interprets the term “use” to include:

(1) Pre-application activities, including, but not limited to:

(i) Arranging for the application of the pesticide;

(ii) Mixing and loading the pesticide; and

(iii) Making necessary preparations for the application of the pesticide, including responsibilities related to worker notification, training of handlers, decontamination, use and care of personal protective equipment, emergency information, and heat stress management.

(2) Application of the pesticide.

(3) Post-application activities necessary to reduce the risks of illness and injury resulting from handlers' and workers' occupational exposures to pesticide residues during the restricted-entry interval plus 30 days. These activities include, but are not limited to, responsibilities related to worker training, notification, and decontamination.

(4) Other pesticide-related activities, including, but not limited to, providing emergency assistance, transporting or storing pesticides that have been opened, and disposing of excess pesticides, spray mix, equipment wash waters, pesticide containers, and other pesticide-containing materials.

(b) A person who has a duty under this part, as referenced on the pesticide product label, and who fails to perform that duty, violates FIFRA section 12(a)(2)(G) and is subject to a civil penalty under section 14. A person who knowingly violates section 12(a)(2)(G) is subject to section 14 criminal sanctions.

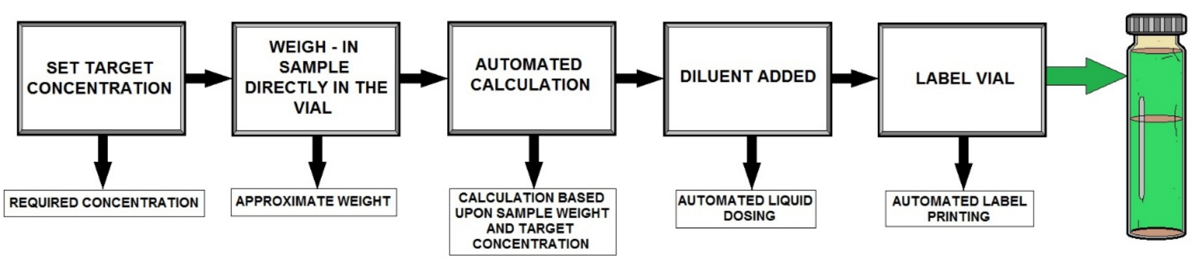
(c) FIFRA section 14(b)(4) provides that a person is liable for a penalty under FIFRA if another person employed by or acting for that person violates any provision of FIFRA. The term “acting for” includes both employment and contractual relationships.

(d) The requirements of this part, including the decontamination requirements, shall not, for the purposes of section 653(b)(1) of title 29 of the U.S. Code, be deemed to be the exercise of statutory authority to prescribe or enforce standards or regulations affecting the general sanitary hazards addressed by the OSHA Field Sanitation Standard, 29 CFR 1928.110, or other agricultural, non-pesticide hazards.

CATEGORIES of PESTICIDE TOXICITY

	CATEGORY I	CATEGORY II	CATEGORY III	CATEGORY IV
SIGNAL WORDS	DANGER / DANGER POISON	WARNING	CAUTION	NONE REQUIRED
ACUTE / ORAL	≤ 50 mg/kg	< 50 - 500 mg/kg	> 500 - 5000 mg/kg	> 5000 mg/kg
ACUTE DERMAL	≤ 200 mg/kg	> 200 - 2000 mg/kg	> 2000 - 5000 mg/kg	> 5000 mg/kg
ACUTE INHALATION	≤ 0.05 mg/L	> 0.05 - 0.5 mg/L	> 0.5 - 2 mg/L	> 2 mg/L
PRIMARY EYE IRRITATION	CORROSIVE	CORNEAL INVOLVEMENT OR OTHER EYE IRRITATION CLEARING IN 8 - 21 DAYS	CORNEAL INVOLVEMENT OR OTHER EYE IRRITATION CLEARING IN ≤ 7 DAYS	MINIMAL EFFECTS CLEARING IN < 24 Hours
PRIMARY SKIN IRRITATION	CORROSIVE	SEVERE IRRITATION AT 72 Hours	MODERATE IRRITATION AT 72 Hours	MILD or SLIGHT IRRITATION AT 72 Hours

TOXICITY OF PESTICIDE CATEGORIES AND SPECIFIC SIGNAL WORDS



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PESTICIDE RESIDUE TESTING

What Employers must do for both Workers and Handlers?

Some WPS protections that employers must provide are nearly the same whether the employees are workers or handlers. This unit describes those requirements. The following unit describes additional requirements that employers must provide to their employees who are **workers**. The next unit describes additional requirements that employers must provide to their employees who are **handlers**. If you employ both workers and handlers, you will need to read all three of these units.

Information at a Central Location

Basic Responsibilities

(See Also Specific Duties Section Below)

Worker employers must make sure that certain information, described below, is displayed at a central location whenever

(1) any **worker** whom they employ is on their agricultural establishment, and

(2) a pesticide is about to be applied or has been recently applied. When agricultural establishments employ their own handlers, **handler employers** of such establishments must make sure that certain information, described below, is displayed at a central location whenever

(1) any **handler** whom they employ is on their agricultural establishment, and

(2) a pesticide has been recently applied. However, this information does not need to be displayed if only commercial (custom) pesticide handlers will be on the agricultural establishment.

Specific Duties

What Information Must Be Displayed?

The following three types of information must be displayed at a central location before a pesticide is applied:

1. Pesticide-specific application information, which must include: the location and description of the area to be treated, product name, EPA registration number, and active ingredient(s) of the pesticide, time and date the pesticide is scheduled to be applied, and restricted-entry interval for the pesticide.

2. Emergency information, which must include the name, telephone number and address of the nearest emergency medical facility.

3. A pesticide safety poster, which must be either the WPS safety poster developed by EPA or an equivalent poster that contains the concepts listed in Criteria for Pesticide Safety Poster.

Where Must the Information Be Displayed?
Display the required information together in a central location on your agricultural establishment where it is readily accessible and can be easily seen and read by workers and handlers.

Exception
If the workplace is a forest, you may display the information **near** the forest. It must be in a location where workers and handlers can easily see and read it and where they are likely to gather or pass by. For example, you might display the information with the decontamination supplies or at an equipment storage site.

Other Responsibilities
1. Inform workers and handlers where the information is located.
2. Allow workers and handlers free, unhampered access to the information.
3. Be sure that the poster, emergency information, and application information remain legible during the time they are posted.
4. Promptly inform workers if there is any change in the information on emergency medical facilities and update the emergency information listed with the poster.

§170.315 Prohibited Actions.
No agricultural employer, commercial pesticide handler employer, or other person involved in the use of a pesticide to which this part applies, shall intimidate, threaten, coerce, or discriminate against any worker or handler for complying with or attempting to comply with this part, or because the worker or handler provided, caused to be provided or is about to provide information to the employer or the EPA or any duly authorized representative of a Federal, State or Tribal government regarding conduct that the worker or handler reasonably believes violates this part, has made a complaint, testified, assisted, or participated in any manner in an investigation, proceeding, or hearing concerning compliance with this part, or has objected to, or refused to participate in, any activity, policy, practice, or assigned task that the worker or handler reasonably believed to be in violation of this part. Any such intimidation, threat, coercion, or discrimination violates FIFRA section 12(a)(2)(G), 7 U.S.C. 136j(a)(2)(G).

§170.317 Violations of this part.
(a) Under FIFRA section 12(a)(2)(G), it is unlawful for any person "to use any registered pesticide in a manner inconsistent with its labeling." When this part is referenced on a label, users must comply with all of its requirements, except those that are inconsistent with product-specific instructions on the pesticide product labeling, except as provided for in §§170.601, 170.603 and 170.607.

(b) A person who has a duty under this part, as referenced on the pesticide product labeling, and who fails to perform that duty, violates FIFRA section 12(a)(2)(G) and is subject to a civil penalty under section 14. A person who knowingly violates section 12(a)(2)(G) is subject to section 14 criminal sanctions.

(c) FIFRA section 14(b)(4) provides that a person is liable for a penalty under FIFRA if another person employed by or acting for that person violates any provision of FIFRA. The term "acting for" includes both employment and contractual relationships, including, but not limited to, labor contractors.

(d) The requirements of this part, including the decontamination requirements, must not, for the purposes of section 653(b)(1) of Title 29 of the U.S. Code, be deemed to be the exercise of statutory authority to prescribe or enforce standards or regulations affecting the general sanitary hazards addressed by the OSHA Field Sanitation Standard, 29 CFR 1928.110, or other agricultural non-pesticide hazards.

Pesticide Safety, Application and Hazard Information   Citation 1.b.

That the employer must provide all the pesticide safety and application and hazard information.

Assure that each employee assigned to handle pesticides is adequately trained in general pesticide safety and about correct pesticide-handling procedures **BEFORE** they are allowed to handle pesticides.

Cover the following subject areas, in a manner the handler-employees can understand, for each pesticide or chemically similar group of pesticides, to be used by your handler-employees.

Pesticide product labeling format and meaning of information, such as precautionary statements about human health hazards.

Hazards of pesticides (**acute, chronic, delayed, and sensitization effects**) identified in pesticide product labeling, Safety Data Sheets (SDS), or PSIS leaflets.

Pesticide safety requirements and procedures in regulation, PSIS leaflets, SDS, including engineering controls (closed systems, enclosed cabs) for handling, transporting, storing, and disposing of pesticides.

Environmental concerns (drift, runoff, and wildlife hazards).

Purposes and requirements of medical supervision, if organophosphate or carbamate pesticides with the signal word "DANGER" or "WARNING" are mixed, loaded, or applied.

Routes by which **pesticides can enter the body**.

Common signs and symptoms of exposure.

Emergency first aid for pesticide exposure.

How to obtain **emergency medical care**.

Routine and emergency decontamination procedures, including spill cleanup and the need to thoroughly shower with soap and warm water after the exposure period.

Use and care of any **required personal protective equipment**.

Prevention, recognition, and first aid for **heat-related illness**.

Warnings about taking pesticides or pesticide containers home.

Location of written WPS Standard and Safety information, PSIS and SDS information.

§170.505 Requirements during Applications to Protect Handlers, Workers, and other Persons

(a) *Prohibition from contacting workers and other persons with pesticides during application.* The handler employer and the handler must ensure that no pesticide is applied so as to contact, directly or through drift, any worker or other person, other than an appropriately trained and equipped handler involved in the application.

(b) *Suspending applications.* After January 1, 2018, the handler performing the application must immediately suspend a pesticide application if any worker or other person, other than an appropriately trained and equipped handler involved in the application, is in the application exclusion zone described in §170.405(a)(1) or the area specified in column B of the Table in §170.405(b)(4).

(c) *Handlers using highly toxic pesticides.* The handler employer must ensure that any handler who is performing any handler activity with a pesticide product that has the skull-and-crossbones symbol on the front panel of the pesticide product label is monitored visually or by voice communication at least every two hours.

(d) *Fumigant applications in enclosed space production.* The handler employer must ensure all of the following:

(1) Any handler in an enclosed space production area during a fumigant application maintains continuous visual or voice contact with another handler stationed immediately outside of the enclosed space.

(2) The handler stationed outside the enclosed space has immediate access to and uses the personal protective equipment required by the fumigant labeling for applicators in the event that entry becomes necessary for rescue.

Which Pesticides Uses are Covered?

Most pesticide uses involved in the production of agricultural plants on a farm, forest, nursery, or greenhouse are covered by the WPS. This includes pesticides used on plants, and pesticides used on the soil or planting medium the plants are (or will be) grown in.

Both general-use and restricted-use pesticides are covered by the WPS.

You will know that the product is covered by the WPS if you see the following statement in the Directions for Use section of the pesticide labeling.

Decontamination Supplies and Requirements   Citation 1.c. & 33.b.

Workers, handlers and early-entry workers must have adequate water for routine washing, soap and sufficient paper towels. Where there is no running water, early-entry workers and handlers must have at least 10 gallons of water for one employee and 20 gallons of water for two or more employees. The water must be of a "quality and temperature" that will not cause illness or injury.

Beginning January, 2017 the water quantity requirements for routine washing and decontamination will change. Where running water is not available you must provide at least one gallon for each worker and three gallons for each handler and early-entry worker as measured at the beginning of the work period.

Also, handlers must have a clean change of clothes -- such as coveralls -- to put on in case their clothes become contaminated.

More permanent decontamination stations with plumbed, running water are appropriate where handlers and workers decontaminate at the end of the day.

Handlers and early-entry workers must also carry a pint of water with them (or it must be "immediately" nearby on their vehicle) for emergency eyeflushing when the pesticide label requires protective eyewear (goggles or faceshield).

A plumbed or portable emergency eyewash station must be provided at:

- All mixing/loading sites and handler decontamination stations when the pesticide requires protective eyewear (goggles or faceshield).
- All permanent mixing/loading sites regardless of whether or not the label requires protective eyewear.

§170.411   Decontamination Supplies for Workers

(a) *Requirement.* The agricultural employer must provide decontamination supplies for routine washing and emergency decontamination in accordance with this section for any worker on an agricultural establishment who is performing an activity in an area where a pesticide was applied and who contacts anything that has been treated with the pesticide, including, but not limited to, soil, water, and plants.

(b) *Materials and quantities.* The decontamination supplies required in paragraph (a) of this section must include at least 1 gallon of water per worker at the beginning of each worker's work period for routine washing and emergency decontamination, soap, and single-use towels. The supplies must meet all of the following requirements:

(1) *Water.* At all times when this part requires agricultural employers to make water available to workers, the agricultural employer must ensure that it is of a quality and temperature that will not cause illness or injury when it contacts the skin or eyes or if it is swallowed. If a water source is used for mixing pesticides, it must not be used for decontamination, unless equipped with properly functioning valves or other mechanisms that prevent contamination of the water with pesticides, such as anti-backflow siphons, one-way or check valves, or an air gap sufficient to prevent contamination.

(2) *Soap and single-use towels.* The agricultural employer must provide soap and single-use towels for drying in quantities sufficient to meet the workers' reasonable needs. Hand sanitizing gels and liquids or wet towelettes do not meet the requirement for soap. Wet towelettes do not meet the requirement for single-use towels.

(c) *Timing.* (1) If any pesticide with a restricted-entry interval greater than four hours was applied, the decontamination supplies must be provided from the time workers first enter the treated area until at least 30 days after the restricted-entry interval expires.

(2) If the only pesticides applied in the treated area are products with restricted-entry intervals of four hours or less, the decontamination supplies must be provided from the time workers first enter the treated area until at least seven days after the restricted-entry interval expires.

(d) *Location.* The decontamination supplies must be located together outside any treated area or area subject to a restricted-entry interval, and must be reasonably accessible to the workers. The decontamination supplies must not be more than ¼ mile from where workers are working, except that where workers are working more than ¼ mile from the nearest place of vehicular access or more than ¼ mile from any non-treated area, the decontamination supplies may be at the nearest place of vehicular access outside any treated area or area subject to a restricted-entry interval.

§170.509 Decontamination and Eye Flushing Supplies for Handlers

(a) *Requirement.* The handler employer must provide decontamination and eye flushing supplies in accordance with this section for any handler that is performing any handler activity or removing personal protective equipment at the place for changing required by §170.507(d)(9).

(b) *General conditions.* The decontamination supplies required in paragraph (a) of this section must include: at least three gallons of water per handler at the beginning of each handler's work period for routine washing and potential emergency decontamination; soap; single-use towels; and clean clothing for use in an emergency. The decontamination and eye flushing supplies required in paragraph (a) of this section must meet all of the following requirements:

(1) *Water.* At all times when this section requires handler employers to make water available to handlers for routine washing, emergency decontamination or eye flushing, the handler employer must ensure that it is of a quality and temperature that will not cause illness or injury when it contacts the skin or eyes or if it is swallowed. If a water source is used for mixing pesticides, it must not be used for decontamination or eye flushing supplies, unless equipped with properly functioning valves or other mechanisms that prevent contamination of the water with pesticides, such as anti-backflow siphons, one-way or check valves, or an air gap sufficient to prevent contamination.

(2) *Soap and single-use towels.* The handler employer must provide soap and single-use towels for drying in quantities sufficient to meet the handlers' needs. Hand sanitizing gels and liquids or wet towelettes do not meet the requirement for soap. Wet towelettes do not meet the requirement for single-use towels.

(3) *Clean change of clothing.* The handler employer must provide one clean change of clothing, such as coveralls, for use in an emergency.

(c) *Location.* The decontamination supplies must be located together outside any treated area or area subject to a restricted-entry interval, and must be reasonably accessible to each handler during the handler activity. The decontamination supplies must not be more than 1/4 mile from the handler, except that where the handler activity is more than 1/4 mile from the nearest place of vehicular access or more than 1/4 mile from any non-treated area, the decontamination supplies may be at the nearest place of vehicular access outside any treated area or area subject to a restricted-entry interval.

(1) *Mixing sites.* Decontamination supplies must be provided at any mixing site.

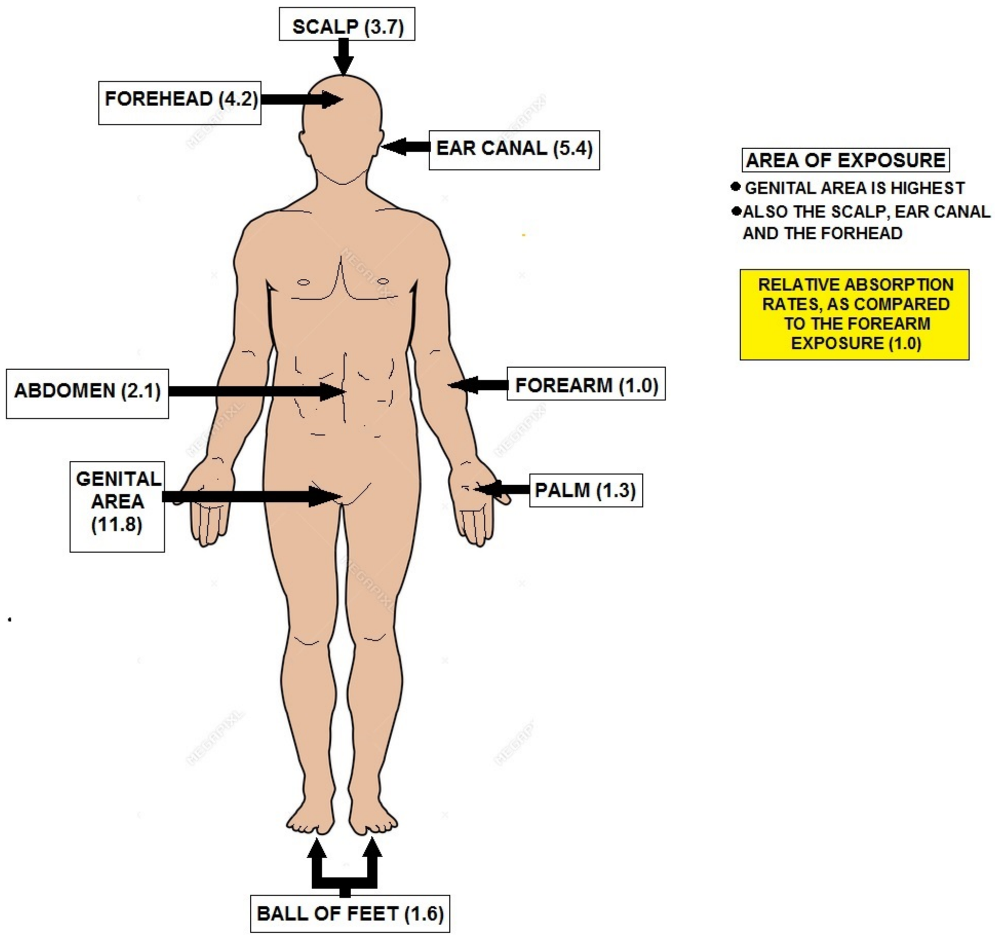
(2) *Exception for pilots.* Decontamination supplies for a pilot who is applying pesticides aerially must be in the aircraft or at the aircraft loading site.

(3) *Exception for treated areas.* The decontamination supplies must be outside any treated area or area subject to a restricted-entry interval, unless the soap, single-use towels, water and clean change of clothing are protected from pesticide contamination in closed containers.

(d) *Emergency eye-flushing.* (1) Whenever a handler is mixing or loading a pesticide product whose labeling requires protective eyewear for handlers, or is mixing or loading any pesticide using a closed system operating under pressure, the handler employer must provide at each mixing/loading site immediately available to the handler, at least one system that is capable of delivering gently running water at a rate of least 0.4 gallons per minute for at least 15 minutes, or at least six gallons of water in containers suitable for providing a gentle eye-flush for about 15 minutes.

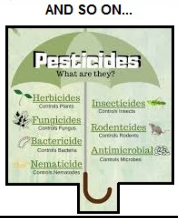
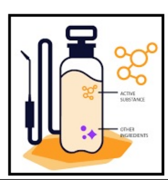
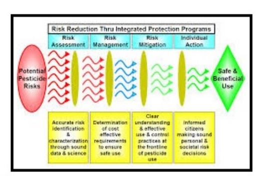
(2) Whenever a handler is applying a pesticide product whose labeling requires protective eyewear for handlers, the handler employer must provide at least one pint of water per handler in portable containers that are immediately available to each handler.

The revised rule will have many concerns that must be specifically addressed, like providing specific amounts of water for workers, 1 gallon per worker and 3 gallons per Handlers.



ABSORPTION RATES OF PESTICIDE EXPOSURE

AGRICULTURAL PESTICIDE FUNDAMENTALS

WHY ARE PESTICIDES USED?	WHAT ARE PESTICIDES?	WHAT ARE PESTICIDES MADE OF?	WHAT ARE THE RISKS ASSOCIATED WITH PESTICIDES?
PESTS CAN DESTROY ENTIRE CROPS WITHOUT MANAGEMENT. THIS CAN CAUSE DRAMATIC LOSS FOR GROWERS, RETAILERS AND ULTIMATELY CONSUMERS. WITHOUT THE USE OF PESTICIDES, IT CAN REQUIRE MORE LABOR AND TIME THAN MOST OF THE LARGE-SCALE GROWERS HAVE. 	PESTICIDES ARE A SUBSTANCE THAT IS / WAS DESIGNED TO KILL, REPEL OR EVEN DETER PESTS. THIS IS USED IN ORDER TO REDUCE DAMAGE CAUSED BY SPECIFIC PESTS. THERE ARE MANY VARIETIES OF PESTICIDES FOR THE MANY KINDS OF PESTS; HERBICIDES KILL WEEDS, FUNGICIDES KILL FUNGUS, INSECTICIDES KILL INSECTS, AND SO ON... 	PESTICIDES ARE MADE OF ONE OR MORE ACTIVE INGREDIENTS THAT ARE USED TO ATTACK PESTS. INACTIVE INGREDIENTS IN PESTICIDES ARE USED FOR OTHER PURPOSES; LIKE ATTRACTING OTHER PESTS OR REDUCE PESTICIDE DRIFT. 	PESTICIDE RISKS DEPEND PRIMARILY ON TWO THINGS: THE TOXICITY OF THE SPECIFIC INGREDIENTS, AND THE EXPOSURE TO THE PESTICIDE ITSELF. SECONDLY, THE RISK IS HIGHER WHEN THE PESTICIDE IS HIGHLY TOXIC AND THERE IS A GREAT POTENTIAL FOR EXPOSURE. 

AGRICULTURAL PESTICIDE FUNDAMENTALS

WPS Requires Providing Decontamination Sites

Employers must establish a decontamination site for all workers and handlers for washing off pesticides and pesticide residues. A decontamination site must be within a quarter (1/4) mile of the employees' work site.

Employers must provide a site where workers and handlers can wash pesticide residue from their hands and body. A decontamination site should supply:

- Enough water for routine and emergency whole body washing and for eye flushing.
- Plenty of soap and single use towels.
- Employers also must provide water that is safe and cool enough for washing, eye flushing, and drinking. Employers may not use tank stored water that also is used for mixing or diluting pesticides.

Specific requirements differ depending whether employees are doing worker or handler tasks. Worker decontamination site requirements:

- Decontamination sites must be provided for workers from application to 30 days after expiration of the REI.
- Worker decontamination sites may not be in areas being treated or under an REI.

No-contact early-entry workers do ***not*** have to be provided the special protections required in Early Entry.

However, they must be provided the following protections offered to other agricultural workers: information at a central location, pesticide safety training for workers, notification, restrictions during applications and during restricted-entry intervals, and emergency assistance. Decontamination supplies, however, need ***not*** be provided to no-contact early-entry workers.

In addition, the WPS requires handlers to:
● **Apply pesticides** in a way that will not expose workers or other persons.
● **Suspend applications** if anyone, other than a trained and equipped handler involved with the application, is in the AEZ during a pesticide application (which may be outside the establishment's property boundary).
● **Wear PPE** specified on the pesticide product labeling.

Mitigation
To address pesticide exposures that employees may experience, the WPS requires employers to provide:
● **Decontamination supplies** — specific amounts of water for workers and handlers along with soap and towels for routine washing and emergency decontamination.
● **Eyewash water** — for handlers using pesticides requiring protective eyewear.
● **Emergency assistance** — making transportation available to a medical care facility if an agricultural worker or handler may have been poisoned or injured by a pesticide, and providing information about the pesticide(s) to which the person may have been exposed to.

The new revision will require the Pesticide Application, <u>nearest</u> Medical Facility and SDSs. Many of these concerns can be addressed in the Informational Poster at the Central Posting Location.

A few of the primary violations according to State Pesticide Inspectors, includes no safety poster, untrained workers and handlers, and no nearby medical facility posting.

Decontamination Supply Requirements

Employers must make sure to provide handlers with decontamination supplies for washing off pesticides and pesticide residues while they are performing handling tasks and to workers who are in a pesticide-treated area and are performing tasks that involve contact with anything that has been treated with pesticides, including soil, water, or plant surfaces.

The WPS requires that decontamination supplies be provided regardless of the number of employees.

Whenever provided to workers or handlers, decontamination and emergency eye-flush water must, at all times, be of a quality and temperature that will not cause illness or injury if it comes in contact with the skin or eyes or if it is swallowed.

Worker Decontamination Supplies
Supplies must be located within ¼ mile of the work area if a WPS-labeled pesticide has been used within 30 days, except in those cases where low-risk pesticides (those with REIs of four hours or less) are used.

When pesticides with an REI of four hours or less are used, decontamination supplies only need to be available for seven days.

Supplies must be located in an area free of spray residues.

Existing facilities, such as restrooms, will qualify as decontamination sites if they meet the minimum requirements for decontamination supplies, which include the following:

1. Water—a minimum of one gallon of water per worker or a source of potable tap water
2. Soap—for use in washing prior to eating, drinking, smoking, chewing tobacco or gum, or using the bathroom
3. Single-use, disposable towels—for drying hands (multiple-use towels are not acceptable)

Handler Decontamination Supplies
Supplies must be provided at the mixing site and within ¼ mile of the application area. Supplies may be in the application area if protected from drift and spray residues.

Supplies must include the following:

1. Water—a minimum of three gallons per handler or a potable source of tap water
2. Soap and single-use towels
3. A whole-body wash—a means of rinsing the handler if a spill occurs
4. Clean clothes or coveralls and a towel for after a whole-body wash
5. Emergency eyewash if the pesticides used require protective eyewear as stated on the label; potable water may be used as eyewash

More on Decontamination Supplies

Basic Responsibilities

(See Also Specific Duties Section Below)

Handler employers must make sure that decontamination supplies (described below) for washing off pesticides and pesticide residues are provided to **handlers** while they are doing handling tasks.

Worker employers must make sure that decontamination supplies (described below) for washing off pesticide residues are provided to **workers** who are working in a pesticide-treated area and are doing tasks that involve contact with anything that has been treated with the pesticide, including soil, water, or surfaces of plants.

Specific Duties

When Must the Supplies Be Provided?

- ✓ For **handlers**, for the duration of the handling task.
- ✓ For **workers**, until 30 days after the end of any restricted-entry interval for that area. If there is no restricted-entry interval, until 30 days after the end of any application in that area.

Exception
When the only pesticides used in the treated area are products with a restricted-entry interval of 4 hours or less, the decontamination supplies must be provided until 7 days after the end of the restricted-entry interval. ***Note****:* When products have no restricted-entry interval listed on the label, the decontamination supplies must be provided until 30 days after the end of any application in that area.

For **early-entry workers who will contact** anything that has been treated with the pesticide, the decontamination supply requirements are different.

Supplies
Provide workers and handlers with:
1. **Water** — enough for:
   • routine washing, and
   • emergency eyeflushing.

*If the water is stored in a tank, the water **must not** be used for mixing pesticides, unless the tank is equipped with correctly functioning anti-backsiphoning or check valves or other mechanisms (such as air gaps) that prevent pesticides from moving into the tank.*

2. **Soap and single use towels** — enough for workers' or handlers' needs.
3. **For handlers**, ***also*** provide:
   • **enough water for washing the entire body** in case of emergency, and
   • **clean change of clothes**, such as one-size-fits-all coveralls, to put on if the handlers' garments are contaminated and need to be removed right away.

Recommendation: How Much Water Should Be Provided?
Obviously, running water meets the requirement. However, if it is not available, use the following guidelines.

• **Workers:** At least 1 gallon of water is recommended for each worker using the supplies. If you find that 1 gallon per worker is inadequate to last for the entire work period, provide more water or replenish the water as needed during the work period.

•**Handlers:** At least 3 gallons of water is recommended for each handler using the supplies. If you find that 3 gallons per handler is inadequate to last for the entire work period, provide more water or replenish the water as needed during the work period.

Location
1. All decontamination supplies for workers must be located together and all decontamination supplies for handlers must be located together. Decontamination supplies must be reasonably accessible to the workers and handlers. Handlers mixing pesticides must have decontamination supplies at the mixing area.

Exceptions:
   • For a pilot who is applying pesticides aerially, the decontamination supplies must be at the aircraft's loading site or in the aircraft.
   • For tasks performed more than 1/4 mile from the nearest point reachable by vehicles (cars, trucks, or tractors), the decontamination supplies may be at the access point. In this circumstance, clean water from springs, streams, lakes, or other sources may be used for decontamination if such water is more readily available than the water at the access point.

Worker decontamination supplies must ***not*** be in an area being treated with pesticides or in an area under a restricted-entry interval.

Handler decontamination supplies may be located in an area being treated with pesticides (or an area that has a restricted-entry interval in effect), **only if**:

- They are in the area where the handler is doing handling tasks,

and

- The soap, single-use towels, and clean change of clothing are in closed containers,

and

- The water is running tap water or is in a closed container.

Emergency Eyeflushing

Provide each **handler** with at least 1 pint of emergency eyeflush water when the pesticide labeling requires protective eyewear for the handling task being performed. The emergency eyeflush water must be **immediately accessible at the mix/load site**.

For example, it could be carried by the handler or be on a vehicle the handler is using. The water that is supplied for general decontamination may also be used as eyeflush water, if it is immediately accessible.

Decontamination After Handling Tasks

At the site where handlers remove their personal protective equipment (PPE), provide:

- soap,
- clean towels, and
- enough water to allow handlers to wash thoroughly after removing PPE.

If the pesticide is not applied as scheduled, you must display the corrected time and date before the application takes place.

If you are unable to make the correction before the application takes place, make it as soon as possible thereafter.

Decontamination Solutions

(1) Decontamination solutions can be used for decontaminating surfaces and materials where spills of dust, granular, wettable powders, or liquid pesticides have occurred. The bulk of the spilled pesticide should be cleaned up or removed prior to applying any decontaminant.

(2) Several materials may be used to decontaminate pesticides. Due to the many different pesticides available and the necessity to use the correct decontamination material, all decontamination activities must be carried out only after appropriate decontamination methods have been determined by the Environmental Coordinator and/or Spill Response Team. Many pesticides, especially the organophosphates, decompose when treated with lye.

Fewer pesticides are decomposed by bleach. Other pesticides cannot be effectively decontaminated and should only be treated with detergent and water to assist in removal. The following table is a guide for decontaminating certain pesticides:

Use Lye or Lime for:	**Use Chlorine Bleach for:**	**Do not use any decontamination Chemicals for these Pesticides:**
acephate	calcium cyanide	alachlor
atrazine	chlorpyrifos	chloramben
captan	fonophos	chlorinated hydrocarbons
carbaryl		diuron
dalapon		methoxychlor
diazinon		pentachlorophenol
dichlorvos		picloram
dimethoate		2,4-D
malathion		bromacil
naled		glyphosate
propoxur		simazine

WARNING: There is a slight potential for creating toxic by-products when using these procedures. In critical situations, samples of affected soil, sediment, water, etc. should be sent to a laboratory for analysis to determine if decontamination was successful.

Pesticides amenable to treatment using lye or lime may be decontaminated when mixed with an excess quantity of either of these materials. Lye or lime can be used in either the dry form or as a 10% solution in water. **Caution**: caustic soda (lye) can cause severe eye damage to personnel not properly protected.

Protect against contact by wearing unventilated goggles, long-sleeved work clothes with coveralls, neoprene gloves, and a chemical-resistant apron. An approved respirator should also be worn. Do not use lye on aluminum surfaces.

Bleach

For pesticides that can be degraded by treatment with bleach, in general use one gallon of household bleach (which contains approximately 5% sodium hypochlorite) per pound or gallon of pesticide spilled. If bleaching powder is used, first mix it with water (one gallon of water per pound of bleach) and add a small amount of liquid detergent.

For safety reasons, a preliminary test must be run using small amounts of bleach and the spilled pesticide. The reaction resulting from this test must be observed to make sure the reaction is not too vigorous.

Do not store in close proximity to, or mix chlorine bleach with, amine-containing pesticides. Mingling of these materials can cause a violent reaction resulting in fire.

Calcium hypochlorite is not recommended as a decontaminating agent because of the fire hazard.

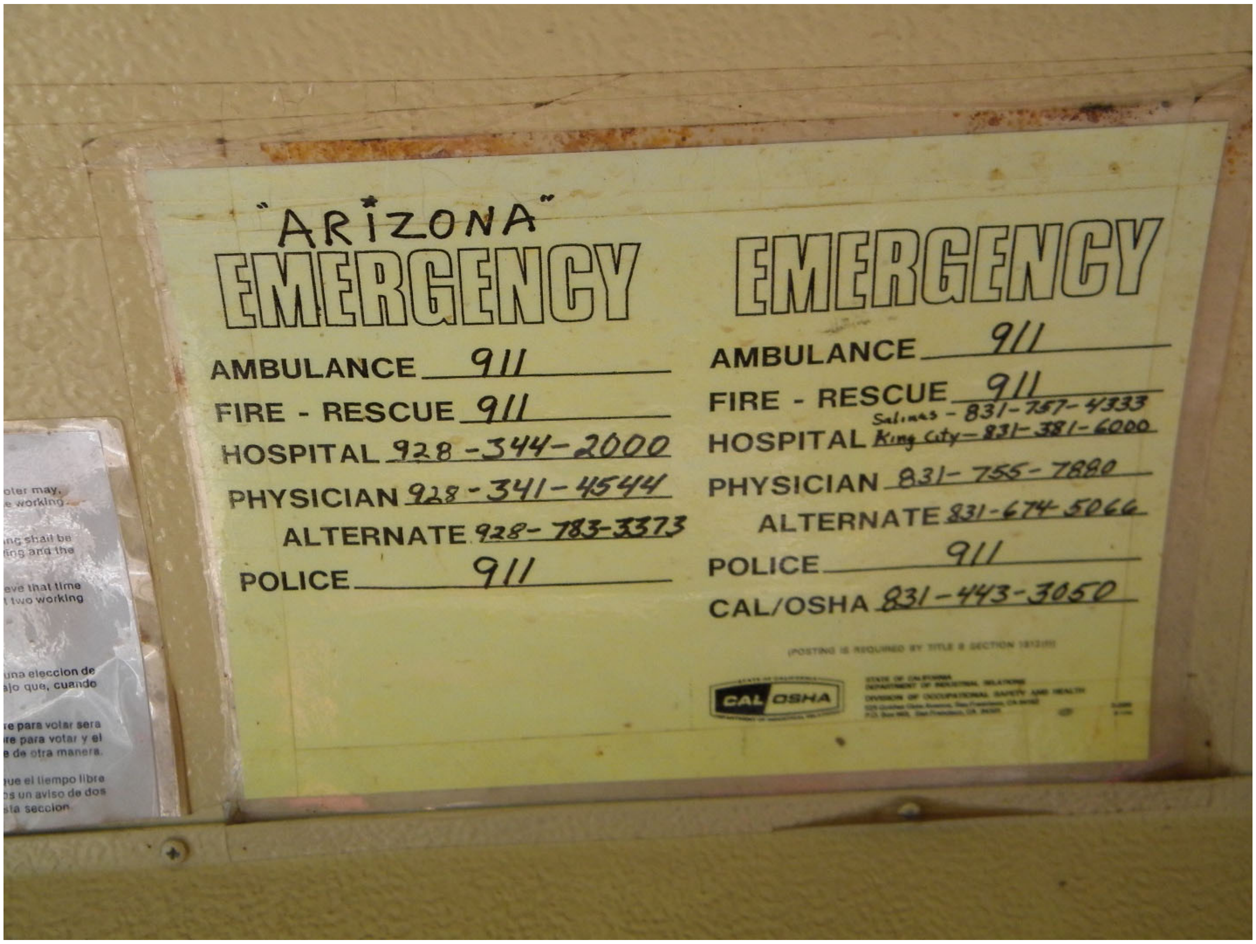
Spilled granular/bait materials need only to be swept up. When there is doubt concerning which decontaminant is appropriate, only water and detergent should be used.

Nonporous surfaces should be washed with detergent and water. The decontamination solution determined to be correct should be thoroughly worked into the surface. The decontamination solution should then be soaked up using absorbent material. The spent absorbent material is then placed into a labeled leakproof container for disposal.

Porous materials such as wood may not be adequately decontaminated. If contamination is great enough to warrant, these materials should be replaced. Tools, vehicles, aircraft, equipment and any contaminated metal or other nonporous objects can be readily decontaminated using detergent and the appropriate decontamination solution.

Disposal
All contaminated materials that cannot be effectively decontaminated as described above must be placed in properly labeled, sealed, leakproof containers. Disposal of these containers shall be in accordance with instructions determined by the U.S. Environmental Protection Agency/State Pesticide Agency and the Spill Response Team.

Common and unnecessary sight at several aerial applicators in the U.S. several empty pesticide cans.



§170.160 Emergency Assistance

If there is reason to believe that a person who is or has been employed on an agricultural establishment to perform tasks related to the production of agricultural plants has been poisoned or injured by exposure to pesticides used on the agricultural establishment, including, but not limited to, exposures from application, splash, spill, drift, or pesticide residues, the agricultural employer shall:

(a) Make available to that person prompt transportation from the agricultural establishment, including any labor camp on the agricultural establishment, to an appropriate emergency medical facility.

(b) Provide to that person or to treating medical personnel, promptly upon request, any obtainable information on:

(1) Product name, EPA registration number, and active ingredients of any product to which that person might have been exposed.
(2) Antidote, first aid, and other medical information from the product labeling.
(3) The circumstances of application or use of the pesticide on the agricultural establishment.
(4) The circumstances of exposure of that person to the pesticide.

Pesticide Safety Training

A handler employer must assure that each handler is properly trained in pesticide safety by a qualified trainer. The minimum pesticide training required, as well as the criteria for qualified trainers, is specified in the standard.

Certified handlers and handlers who have been trained under 40 Code of Federal Regulations, Part 171 are exempt from this requirement.

If there is reason to believe that an employee has been poisoned or injured by a pesticide exposure, you must provide prompt transportation to an emergency medical facility.

You must provide information about the circumstances of the exposure and the pesticide(s) involved. Bring product labels with you.

§170.313 Commercial Pesticide Handler Employer Duties

(k) Provide emergency assistance in accordance with this paragraph. If there is reason to believe that a handler employed by the commercial pesticide handling establishment has experienced a potential pesticide exposure during his or her employment by the commercial pesticide handling establishment or shows symptoms similar to those associated with acute exposure to pesticides during or within 72 hours after his or her employment by the commercial pesticide handling establishment, and needs emergency medical treatment, the commercial pesticide handler employer must do all of the following promptly after learning of the possible poisoning or injury:

(1) Make available to that person transportation from the commercial pesticide handling establishment, or any agricultural establishment on which that handler may be working on behalf of the commercial pesticide handling establishment, to an operating medical care facility capable of providing emergency medical treatment to a person exposed to pesticides.

(2) Provide all of the following information to the treating medical personnel:

(i) Copies of the applicable safety data sheet(s) and the product name(s), EPA registration number(s) and active ingredient(s) for each pesticide product to which the person may have been exposed.

(ii) The circumstances of application or use of the pesticide.

(iii) The circumstances that could have resulted in exposure to the pesticide.

(l) Ensure that persons directly employed by the commercial pesticide handling establishment do not clean, repair, or adjust pesticide application equipment, unless trained as a handler under §170.501. Before allowing any person not directly employed by the commercial pesticide handling establishment to clean, repair, or adjust equipment that has been used to mix, load, transfer, or apply pesticides, the commercial pesticide handler employer must provide all of the following information to such persons:

(1) Notice that the pesticide application equipment may be contaminated with pesticides.

(2) The potentially harmful effects of exposure to pesticides.

(3) Procedures for handling pesticide application equipment and for limiting exposure to pesticide residues.

(4) Personal hygiene practices and decontamination procedures for preventing pesticide exposures and removing pesticide residues.

(m) Provide any records or other information required by this part for inspection and copying upon request by an employee of EPA or any duly authorized representative of a Federal, State or Tribal government agency responsible for pesticide enforcement.

Worker employers must provide emergency assistance, described below, to anyone who is or has been employed as a **worker** on their farm, forest, nursery, or greenhouse if there is reason to believe that the worker has been poisoned or injured by a pesticide used on the agricultural establishment — for example, through application, spills, splashes, drift, or contact with pesticide residues.

Pesticide handler employers must provide emergency assistance, described below, to anyone who is or has been employed as a **handler** on their farm, forest, nursery, or greenhouse or on their commercial pesticide handling establishment, if there is reason to believe that the handler has been poisoned or injured by a pesticide as a result of that employment — for example, through application, spills, splashes, drift, handling tasks, or contact with pesticide residues.

Specific Duties - Emergency Transportation
1. Promptly make emergency transportation available to take the **worker** to an emergency medical facility able to provide treatment and bring the SDS:

- from the agricultural establishment, *or Employers can "make transportation taking the employee to the emergency medical facility,* or *calling an such as an ambulance,* or *making sure the employee has a ride to the medical and facility with someone else.*
- from a labor camp located on the establishment.

2. Promptly make emergency transportation available to take the **handler** to an *available" by:* emergency medical facility able to provide treatment and provide a copy of the SDS:

- from the agricultural establishment, *or*

- from another handling site, such as a commercial handling establishment or an airport hangar.

Emergency Information
Provide to the worker or handler or to treating medical personnel the SDS, promptly upon *emergency vehicle,* request, any obtainable information on:

- product name, EPA registration number, and active ingredients for any product(s) to which the person may have been exposed,

- antidote, first aid, statement of practical treatment and other medical or emergency information from the product labeling,

- description of the way the pesticide was being used,

- circumstances of the worker's or handler's exposure to the pesticide.

If there is reason to believe that a worker has been poisoned or injured by pesticides, the employer must make prompt transportation to a medical facility available to the worker. On request the employer must provide, to either the worker or medical personnel providing treatment, information about the product including the EPA registration number, active ingredients in any product the worker might have been exposed to in the past 30 days, antidote and other first aid information from the product labeling, and information about the application and the exposure of workers to the pesticide.

Requirements for Handlers
The general applicability, exceptions and exemptions in the requirements for handlers and workers are the same. However, the requirements for handlers have specific differences.

Restrictions During Application
The handler employer must assure that:

- No pesticide is applied so as to contact any worker (directly or through drift) other than an appropriately trained and equipped handler.

- Workers handling highly toxic pesticides are monitored visually or by voice communication at least every 2 hours.

- ➢ Any worker who handles a fumigant in an enclosed space production, (greenhouse) including a handler entering before acceptable safe entry criteria have been met, maintains continuous visual or voice contact with another handler who has immediate access to the required PPE if rescuing the handler in the greenhouse becomes necessary.

Notice of Application to Agricultural Employers
Prior to applying any pesticide on an agricultural establishment, a handler employer must provide the following information to an agricultural employer or be assured that the agricultural employer is aware of the specific time, date, location, and description of the pesticide-treated area, labeling requirements relating to protection of workers during or after application, product name, the EPA registration number, active ingredients, REI, and notification requirements.

Pesticide Safety Training
A handler employer must assure that each handler is properly trained in pesticide safety by a qualified trainer.

The minimum pesticide training required, as well as the criteria for qualified trainers, is specified in the standard. Certified handlers and handlers who have been trained under 40 Code of Federal Regulations, Part 171 are exempt from this requirement.

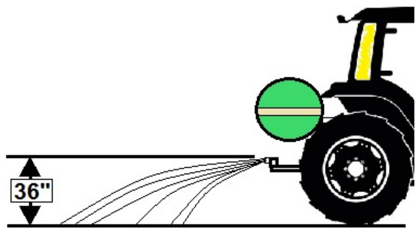
The following are key requirements for training workers and handlers:
There is no grace period for WPS training! The agricultural employer must ensure that WPS training is completed within the last 12 months before:

- ✓ Any worker enters a treated area on an agricultural establishment where, within the last 30 days, a WPS-labeled pesticide product has been used or a REI for such pesticide has been in effect.
- ✓ Any handler conducts any handling task.

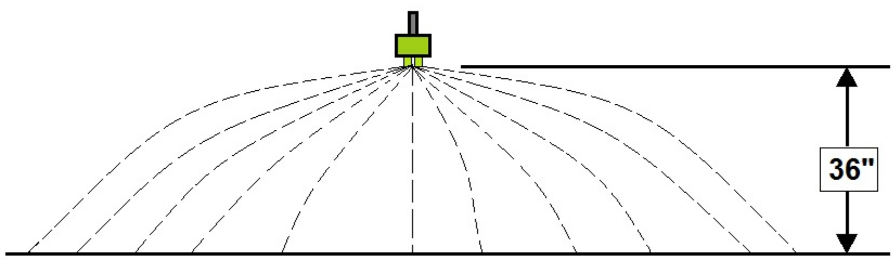
● Workers and handlers are exempt from WPS training if they are currently:

- ✓ Certified as an applicator of restricted-use pesticides.
- ✓ Certified as a crop advisor by a program acknowledged as appropriate in writing by EPA, or a State or Tribal agency responsible for pesticide enforcement. 170.401(b)

● Additionally, a worker is exempt from WPS worker training if they have been trained as a WPS handler within the last 12 months.
● Only qualified trainers may provide WPS training.
● Train workers and handlers annually.
● Provide training in a manner that the workers or handlers can understand, using a translator if necessary.
● Present training using EPA-approved materials either orally from written materials or audio-visually.
● Keep records of worker or handler training for 2 years.
● Make training records available to employees upon request.
● All training requirements are effective January 2, 2017 EXCEPT the expanded training content which is effective January 2, 2018.

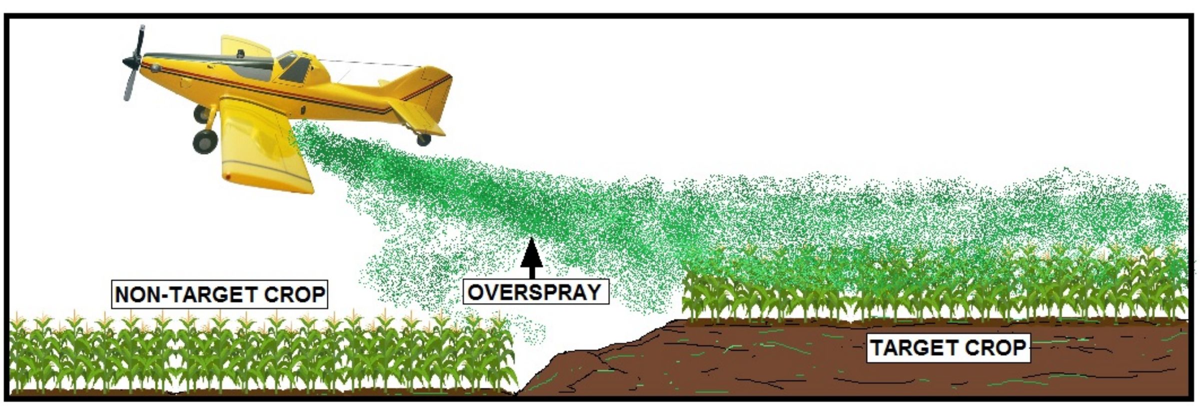


NOZZLE MOUNTED VERTICALLY



BOOMLESS NOZZLE SPRAYER

Technical Learning College



EXAMPLE OF AERIAL APPLICATION OVERSPRAY HAZARDS

Technical Learning College

Worker Notification of Restrictions During Applications Citation 1.e.

The employer shall notify to workers of restrictions during applications.

§170.405 Entry Restrictions Associated with Pesticide Applications.

(a) *Outdoor production pesticide applications.* (1) The application exclusion zone is defined as follows:

(i) The application exclusion zone is the area that extends 100 feet horizontally from the application equipment in all directions during application when the pesticide is applied by any of the following methods:

(A) Aerially.

(B) Air blast application.

(C) As a spray using a spray quality (droplet spectrum) of smaller than medium (volume median diameter of less than 294 microns).

(D) As a fumigant, smoke, mist, or fog.

(ii) The application exclusion zone is the area that extends 25 feet horizontally from the application equipment in all directions during application when the pesticide is applied not as in §170.405(a)(1)(i)(A)-(D) and is sprayed from a height of greater than 12 inches from the planting medium using a spray quality (droplet spectrum) of medium or larger (volume median diameter of 294 microns or greater).

(iii) There is no application exclusion zone when the pesticide is applied in a manner other than those covered in paragraphs (a)(1)(i) and (a)(1)(ii) of this section.

(2) During any outdoor production pesticide application, the agricultural employer must not allow or direct any worker or other person, other than an appropriately trained and equipped handler involved in the application, to enter or to remain in the treated area or an application exclusion zone that is within the boundaries of the establishment until the application is complete.

(3) After the application is complete, the area subject to the labeling-specified restricted-entry interval and the post-application entry restrictions specified in §170.407 is the treated area.

(b) *Enclosed space production pesticide applications.* (1) During any enclosed space production pesticide application described in column A of the Table under paragraph (b)(4) of this section, the agricultural employer must not allow or direct any worker or other person, other than an appropriately trained and equipped handler involved in the application, to enter or to remain in the area specified in column B of the Table under paragraph (b)(4) of this section during the application and until the time specified in column C of the Table under paragraph (b)(4) of this section has expired.

(2) After the time specified in column C of the Table under paragraph (b)(4) of this section has expired, the area subject to the labeling-specified restricted-entry interval and the post-application entry restrictions specified in §170.407 is the area specified in column D of the Table under paragraph (b)(4) of this section.

(3) When column C of the Table under paragraph (b)(4) of this section specifies that ventilation criteria must be met, ventilation must continue until the air concentration is measured to be equal to or less than the inhalation exposure level required by the labeling. If no inhalation exposure level is listed on the labeling, ventilation must continue until after one of the following conditions is met:

(i) Ten air exchanges are completed.

(ii) Two hours of ventilation using fans or other mechanical ventilating systems.

(iii) Four hours of ventilation using vents, windows, or other passive ventilation.

(iv) Eleven hours with no ventilation followed by one hour of mechanical ventilation.

(v) Eleven hours with no ventilation followed by two hours of passive ventilation.
(vi) Twenty-four hours with no ventilation.
(4) The following Table applies to paragraphs (b)(1), (2), and (3) of this section.

§170.505 Requirements during Applications to Protect Handlers, Workers, and other Persons

(a) *Prohibition from contacting workers and other persons with pesticides during application.* The handler employer and the handler must ensure that no pesticide is applied so as to contact, directly or through drift, any worker or other person, other than an appropriately trained and equipped handler involved in the application.
(b) *Suspending applications.* After January 1, 2018, the handler performing the application must immediately suspend a pesticide application if any worker or other person, other than an appropriately trained and equipped handler involved in the application, is in the application exclusion zone described in §170.405(a)(1) or the area specified in column B of the Table in §170.405(b)(4).
(c) *Handlers using highly toxic pesticides.* The handler employer must ensure that any handler who is performing any handler activity with a pesticide product that has the skull-and-crossbones symbol on the front panel of the pesticide product label is monitored visually or by voice communication at least every two hours.
(d) *Fumigant applications in enclosed space production.* The handler employer must ensure all of the following:
(1) Any handler in an enclosed space production area during a fumigant application maintains continuous visual or voice contact with another handler stationed immediately outside of the enclosed space.
(2) The handler stationed outside the enclosed space has immediate access to and uses the personal protective equipment required by the fumigant labeling for applicators in the event that entry becomes necessary for rescue.

Worker Notification of Restrictions to Treated Areas Citation 1.f.

§170.224 Notice of Applications to Agricultural Employers.

Before the application of any pesticide on or in an agricultural establishment, the handler employer shall provide the following information to any agricultural employer for the establishment or shall assure that any agricultural employer is aware of:

(a) Specific location and description of the treated area.

(b) Time and date of application.

(c) Product name, EPA registration number, and active ingredient(s).

(d) Restricted-entry interval.

(e) Whether posting and oral notification are required.

(f) Any other product-specific requirements on the product labeling concerning protection of workers or other persons during or after application.

§170.110 Restrictions Associated with Pesticide Applications.

(a) *Farms and forests.* During the application of any pesticide on a farm or in a forest, the agricultural employer shall not allow or direct any person, other than an appropriately trained and equipped handler, to enter or to remain in the treated area.

(b) *Nurseries.* In a nursery, during any pesticide application described in column A of Table 1 of this paragraph, the agricultural employer shall not allow or direct any person, other than an appropriately trained and equipped handler, to enter or to remain in the area specified in column B of Table 1 of this paragraph. After the application is completed, until the end of any restricted-entry interval, the entry-restricted area is the treated area.

TABLE 1—ENTRY-RESTRICTED AREAS IN NURSERIES DURING PESTICIDE APPLICATIONS

A. During Application of a Pesticide:	B. Workers are Prohibited in:
(1)(a) Applied:	Treated area plus 100 feet in all directions on the nursery
(i) Aerially, or	
(ii) In an upward direction, or	
(iii) Using a spray pressure greater than 150 psi, or	
(b) Applied as a:	
(i) Fumigant, or	
(ii) Smoke, or	
(iii) Mist, or	
(iv) Fog, or	
(v) Aerosol.	
(2)(a) Applied downward using:	Treated are plus 25 feet in all directions on the nursery
(i) A height of greater than 12 inches from the planting medium, or	
(ii) A fine spray, or	

(iii) A spray pressure greater than 40 psi and less than 150 psi.	
(b) Not as in 1 or 2(a) above but for which a respiratory protection device is required for application by the product labeling.	
(3) Applied otherwise.	Treated area

(c) *Greenhouses.* (1) When a pesticide application described in column A of Table 2 under paragraph (c)(4) of this section takes place in a greenhouse, the agricultural employer shall not allow or direct any person, other than an appropriately trained and equipped handler, to enter or to remain in the area specified in column B of Table 2 until the time specified in column C of Table 2 has expired.

(2) After the time specified in column C of Table 2 under paragraph (c)(4) of this section has expired, until the expiration of any restricted-entry interval, the agricultural employer shall not allow or direct any worker to enter or to remain in the treated area as specified in column D of Table 2 under paragraph (c)(4) of this section, except as provided in §170.112.

(3) When column C of Table 2 under paragraph (c)(4) of this section specifies that ventilation criteria must be met, ventilation shall continue until the air concentration is measured to be equal to or less than the inhalation exposure level the labeling requires to be achieved. If no inhalation exposure level is listed on the labeling, ventilation shall continue until after:

(i) Ten air exchanges are completed; or
(ii) Two hours of ventilation using fans or other mechanical ventilating systems; or
(iii) Four hours of ventilation using vents, windows or other passive ventilation; or
(iv) Eleven hours with no ventilation followed by 1 hour of mechanical ventilation; or
(v) Eleven hours with no ventilation followed by 2 hours of passive ventilation; or
(vi) Twenty-four hours with no ventilation.
(4) The following Table 2 applies to paragraphs (c) (1), (2), and (3) of this section.

TABLE 2—GREENHOUSE ENTRY RESTRICTIONS ASSOCIATED WITH PESTICIDE APPLICATIONS

A. When a Pesticide is Applied:	B. Workers are Prohibited in:	C. Until:	D. After the Expiration of Time in Column C Until the Restricted-Entry Interval Expires, the Entry-Restricted Area is:
(1) As a fumigant	Entire greenhouse plus any adjacent structure that cannot be sealed off from the treated area	The ventilation criteria of paragraph (c)(3) of this section are met	No entry restrictions after criteria in column C are met
(2) As a	Entire enclosed area	The ventilation criteria of paragraph (c)(3) of this section are met	Entire enclosed area is the treated area
(i) Smoke, or			
(ii) Mist, or			
(iii) Fog, or			
(iv) Aerosol			
(3) Not in 1 or 2 above, and for which a respiratory protection device is required for application by the product labeling	Entire enclosed area	The ventilation criteria of paragraph (c)(3) of this section are met	Treated area
(4) Not in 1, 2, or 3 above, and:	Treated area plus 25 feet in all directions in the enclosed area	Application is complete	Treated area
(i) From a height of greater than 12 in. from the planting medium, or			
(ii) As a fine spray, or			
(iii) Using a spray pressure greater than 40 psi			
(5) Otherwise	Treated area	Application is complete	Treated area

Further Requirements for Employers of Workers
Notice about Applications

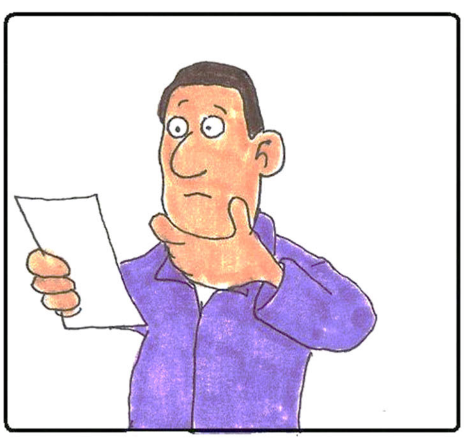
Basic Responsibilities
(See Also Specific Duties Section Below)
Under most circumstances, **worker employers** must make sure that **workers** are notified about areas where pesticide applications are taking place or where restricted-entry intervals are in effect.

Specific Duties - Both Oral Warnings and Posted Signs
Some pesticide labels require you to notify workers ***both*** orally ***and*** with signs posted at entrances to the treated area. If both types of notification are required, the following statement will be in the “Directions for Use” section of the pesticide labeling under the heading “Agricultural Use Requirements”:

“**Notify workers of the application by warning them orally and by posting warning signs at entrances to treated areas**.”

Notification on Farms, Forests, and Nurseries
Unless the pesticide labeling requires both types of notification, notify workers ***either*** orally ***or*** by the posting of warning signs at entrances to treated areas. You must inform workers which method of notification is being used.

Notification in Greenhouses
In greenhouses, **you must post all treated areas**, except as described below. If the pesticide labeling requires both types of notification, you must also notify workers orally.



READ THE SAFETY DATA SHEET

WEAR PROPER PPE

HANDLING CHEMICALS

Exceptions to Worker Notification

1. **Oral warnings** need ***not*** be given to:
   - **any** worker on your farm, forest, or nursery who will not be in the treated area, or walk within 1/4 mile of a treated area, during the pesticide application or while the restricted-entry interval is in effect,
   - **any** worker who will not be in your greenhouse during a pesticide application or while a restricted-entry interval is in effect there, ***or***
   - **any** worker who applied (or supervised the application of) the pesticide and is aware of all of the information required to be given in the oral warning.

2. Treated area posting is ***not*** required if:
   - **no** workers on your farm, forest, or nursery will be in the treated area, or walk within 1/4 mile of the treated area, during the pesticide application or while the restricted-entry interval is in effect,
   - **no** workers will be in the greenhouse during the pesticide application or while the restricted-entry interval is in effect there, ***or***
   - the **only** workers for whom you need to post applied (or supervised the application of) the pesticide and are aware of all of the information required to be given in the oral warning.

Posted Warning Signs

Signs meeting these Use WPS-design signs when you post warnings at entrances to treated areas. For all *requirements should be* detailed description, see Requirements for Warning Signs.

1. **Location:**

• **On farms, forests, and nurseries**, post the signs so they can be seen from all points where workers usually enter the treated area, including at least: – each access road, – each border with any labor camp adjacent to the treated area, and – each established walking route that enters the treated area.

When there are no usual points of worker entry, post the signs in the corners of the treated area or in places where they will be most easily seen.

• **In greenhouses**, post the signs so they can be seen from all points where workers usually enter the treated area, including doorways, aisles, and other walking routes. When there are no usual points of worker entry to the treated area, post the signs in the corners of the treated area or in places where they will be easily seen.

2. **Timing and Visibility of Warning Signs**:
   - Post signs 24 hours or less before the scheduled application of the pesticide.
   - Keep signs posted during application and throughout the restricted-entry interval (if any),
   - Remove the signs within 3 days after the end of the restricted-entry interval. If there is no restricted-entry interval for that application, remove the signs within 3 days after the end of the application.
   - Keep workers out during the entire time the signs are posted, (except for trained and equipped early-entry workers entering as permitted under WPS).
   - Keep signs visible and legible while they are posted.

3. **Posting Adjoining Areas** When several adjoining areas are to be treated with pesticides on a rotating or sequential *Requirements for Warning Signs, you* may post the entire area at the same time. Worker entry, except for early entry *description, see* permitted by the WPS, is prohibited for the entire area while the signs are posted.

4. **Design and Size**

• Each warning sign must look like this:

Exception:

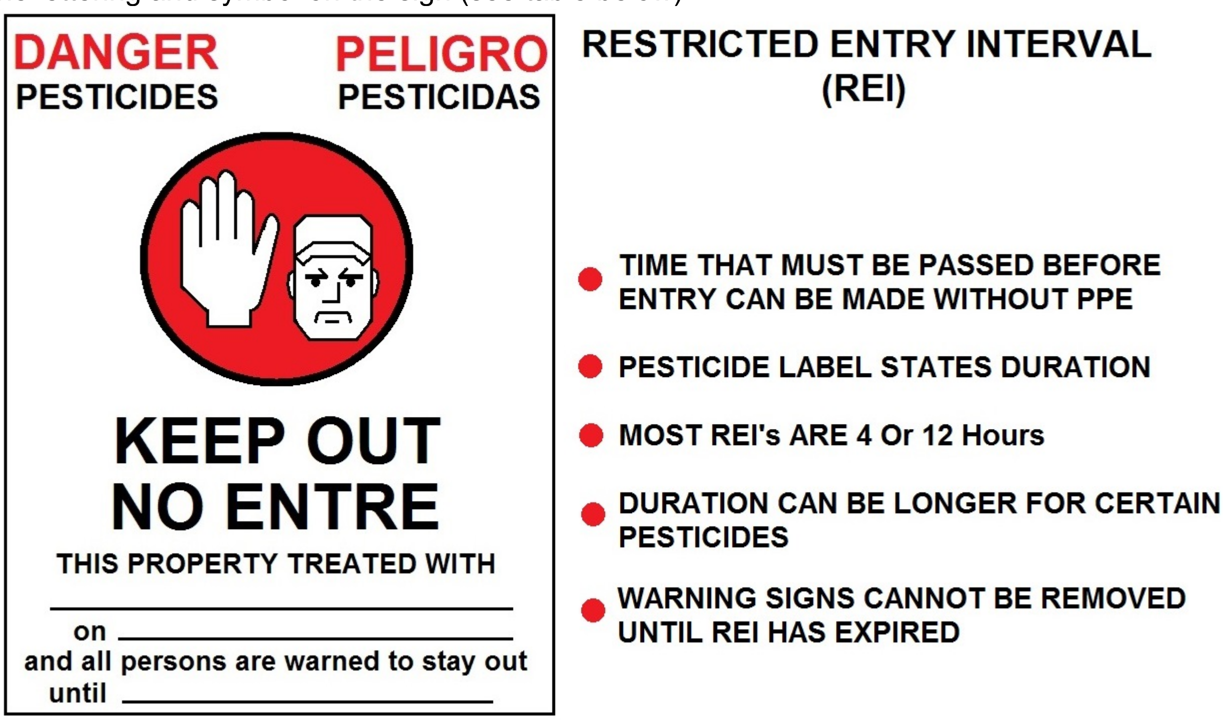
As an option, you may use warning signs that replace the Spanish words with the same words in **Red** another language (other than English) that is read by the largest number of your workers who do not read English. The replacement sign must meet all other requirements for the WPS warning sign.

> • You may put **additional information** on the warning sign, such as the name of the pesticide or the date of application, if it does not lessen the impact of the sign or change the meaning of the required information. If you add the required information in other languages, the words must be translated correctly.
>
> • The signs must be at least 14 inches by 16 inches, and the letters must be at least 1 inch high.

Exception:

On farms and forests, you may use smaller signs if the treated area is too small to accommodate 14- by 16-inch signs. For example, when a single plant needs to be posted, a smaller sign would be appropriate. In nurseries and greenhouses, you may, at any time, use a sign smaller than the standard size.

Whenever a small sign is used, there are specific posting distances depending on the size of the lettering and symbol on the sign (see table below).



Sign Size
Signs with the words “DANGER” and “PELIGRO” in letters less than 7/16 inch in height **or** with any words in letters less than 1/4 inch in height **or** with the circle graphic containing an upraised hand and a stern face less than 1½ inches in diameter do not meet WPS sign requirements.
* This distance requirement is for places where multiple signs are used to post a single treated area, such as a field or a greenhouse section. It does not apply where individual signs are used for separate small treatment areas (such as single potted plants in a greenhouse).

Oral Warnings to Workers
1. **Content**:
Oral warnings must include:
- the location and description of the treated area,
- the time during which entry is restricted, and
- instructions not to enter the treated area until the restricted-entry interval has expired.

2. **Communication**:
Provide oral warnings to workers in a manner that they can understand.

3. **Timing**:
- Workers who are on your establishment at the start of an application must be orally warned **before the application takes place**.
- Workers who are ***not*** on your establishment at the start of an application must be orally warned **at the beginning of their first work period** if (1) the application is still taking place or (2) the restricted-entry interval for the pesticide is in effect.

*Entering either enclosed or outdoor fumigated areas to ventilate, remove tarps or other coverings used in the fumigation, or to measure air concentration levels are **handling tasks**, not early entry. Only appropriately trained and equipped handlers can do these tasks.*

Restrictions During and After Applications
Basic Responsibilities
Worker employers must take actions, described below, to protect **workers and other persons** during pesticide applications on agricultural establishments. **Worker employers** also must take actions, described below, to protect **workers** during restricted-entry intervals.

Specific Duties - During Applications
1. Keep everyone except appropriately trained and equipped handlers out of areas being treated with pesticides.

2. In nurseries and greenhouses, during some applications, also keep workers and other persons out of the area **immediately around** the area being treated. The size of this “keep-out zone” depends on the pesticide used and the application method. In some greenhouse situations, the greenhouse must be adequately ventilated before workers are allowed to enter.

During Restricted-Entry Intervals
In general, keep workers out of a treated area during the restricted-entry interval. This restriction has only two types of exceptions:
(1) early entry **with no contact**, described below, and
(2) early entry **with contact** for short-term, emergency, or specially excepted tasks.

Note, however, that entry into treated areas during a restricted-entry interval is also allowed to perform handling (including crop advisor) tasks as long as the persons entering such areas are trained and equipped as pesticide handlers and receive all other applicable WPS handler protections.

0 - 4 Hours	4 - 12 Hours	12 - 24 Hours	24 + Hours
DO NOT ENTER	EARLY RE-ENTRY BY A CERTIFIED FARMER	EARLY RE-ENTRY BY WORKERS	ALL ENTRY
- THE END OF THE APPLICATION IS THE START OF THE 24-Hour RESTRICTED ENTRY INTERVAL - NO ONE MAY ENTER THE TREATED AREA	- MUST NOT DO ANY LABOR TASKS - MUST ONLY BE THE AREA FOR LESS THAN 24 - Hours - MUST WEAR THE PROTECTIVE CLOTHING AND PPE STATED ON THE LABEL FOR MIXING PLUS WEAR: NIOSH-APPROVED RESPIRATOR	- MUST NOT DO ANY LABOR TASKS - CANNOT CONTACT ANY SURFACES THAT MAY HAVE RESIDUES - MUST WEAR THE PROTECTIVE CLOTHING AND PPE ITEMS IF THEY ARE STATED ON THE LABEL FOR EARLY RE-ENTRY	- END OF REI ONLY ON A LABEL WITH A RE-ENTRY FROM 24 Hours TO SEVERAL DAYS - EVERYONE MAY ENTER

EXAMPLE OF AN REI (Restricted Entry Interval) FROM A PESTICIDE LABEL

Restricted–Entry Interval (REI)
The restricted-entry interval is the time immediately after a pesticide application when entry into the treated area is limited. Some pesticides have one REI, such as 12 hours, for all crops and uses. Other products have different REIs depending on the crop or method of application. When two (or more) pesticides are applied at the same time, and have different REIs, you must follow the longer interval.

Location of REIs on Labeling
The restricted-entry interval is listed on the pesticide labeling:

- under the heading “Agricultural Use Requirements” in the “Directions for Use” section of the pesticide labeling, or
- next to the crop or application method to which it applies.

Arid Area REIs
Some pesticide labeling require a different REI for arid areas. Labeling might say, for example, “72 hours in outdoor areas where average annual rainfall is less than 25 inches a year.” You can get information on average annual rainfall for your area from any nearby weather bureau, such as one located at a local airport or one affiliated with the National Oceanographic and Atmospheric Administration.

No Contact Early Entry
If workers **will have no contact with anything that has been treated with the pesticide** to which the restricted-entry interval applies, you may permit them to enter pesticide-treated areas when the application is finished.

1. After any inhalation exposure level listed on the product labeling has been reached or any WPS ventilation criteria have been met, you may permit workers into a treated area

Avoiding contact by during an REI if they will ***not* touch or be touched by** any pesticide residues, including: *using personal protective equipment does **not** qualify as no contact early entry.*

• **on plants**, including both agricultural plants and weeds,
• **on or in soil** or planting medium,
• **in water**, such as irrigation water or water standing in drainage ditches or puddles,
• **in air**, if pesticide remains suspended after application, such as after fumigation or after a smoke, mist, fog, or aerosol application.

Employers must provide current and specific information about the pesticides being applied for the benefit of their employees (handlers and workers). Employees must be informed of the central location and allowed access.

Employers (owner/operator of agricultural establishments) must post the following information just prior to applications and for 30 days after the REI has expired whenever pesticide handlers or workers are on the agricultural establishment:

- an approved EPA safety poster or an equivalent
- emergency medical information, including the name, address and telephone number of the nearest emergency medical care facility
- a list of dates and times that pesticides have been applied within the last 30 days, including a description of each treated area, and the product name, EPA registration number, active ingredient(s) and REI for each pesticide on that list

The information at the central location must be easily seen and read. Workers and handlers must be informed where it is and given access. By "access," the EPA wants the workers to be able to view the information without having to ask anyone to let them see it.

Some examples of a central location include: field or forest entrance; parking area; common areas; break areas; port-a-pots. The central location cannot be in a treated area. The EPA safety poster or an equivalent need to show how to keep pesticides from getting on or entering the body and information about how to clean up if an individual comes in contact with pesticides.

If the emergency medical information changes, update the posted information in the central location and ensure that it remains legible. Pesticide applications must remain on the list from before each application begins and remain posted through 30 days after the REI has expired. The list must remain accessible by the workers for the entire required posting period at the designated central location.

Handlers and workers must be informed of pesticide label requirements and information. A grower must have all the safety data sheets (**SDS**) of the labeled pesticides he/she is using on file and available upon request.

§170.112 Entry Restrictions

(a) *General restrictions.* (1) After the application of any pesticide on an agricultural establishment, the agricultural employer shall not allow or direct any worker to enter or to remain in the treated area before the restricted-entry interval specified on the pesticide labeling has expired, except as provided in this section.

(2) Entry-restricted areas in greenhouses are specified in column D in table 2 under §170.110(c)(4).

(3) When two or more pesticides are applied at the same time, the restricted-entry interval shall be the longest of the applicable intervals.

(4) The agricultural employer shall assure that any worker who enters a treated area under a restricted-entry interval as permitted by paragraphs (c), (d), and (e) of this section uses the personal protective equipment specified in the product labeling for early-entry workers and follows any other requirements on the pesticide labeling regarding early entry.

(b) *Exception for activities with no contact.* A worker may enter a treated area during a restricted-entry interval if the agricultural employer assures that both of the following are met:

(1) The worker will have no contact with anything that has been treated with the pesticide to which the restricted-entry interval applies, including, but not limited to, soil, water, air, or surfaces of plants; and

(2) No such entry is allowed until any inhalation exposure level listed in the labeling has been reached or any ventilation criteria established by §170.110(c)(3) or in the labeling have been met.

(c) *Exception for short-term activities.* A worker may enter a treated area during a restricted-entry interval for short-term activities if the agricultural employer assures that the following requirements are met:

(1) No hand labor activity is performed.

(2) The time in treated areas under a restricted-entry interval for any worker does not exceed 1 hour in any 24-hour period.

(3) No such entry is allowed for the first 4 hours following the end of the application, and no such entry is allowed thereafter until any inhalation exposure level listed in the labeling has been reached or any ventilation criteria established by §170.110(c)(3) or in the labeling have been met.

(4) The personal protective equipment specified on the product labeling for early entry is provided to the worker. Such personal protective equipment shall conform to the following standards:

(i) Personal protective equipment (PPE) means devices and apparel that are worn to protect the body from contact with pesticides or pesticide residues, including, but not limited to, coveralls, chemical-resistant suits, chemical-resistant gloves, chemical-resistant footwear, respiratory protection devices, chemical-resistant aprons, chemical-resistant headgear, and protective eyewear.

(ii) Long-sleeved shirts, short-sleeved shirts, long pants, short pants, shoes, socks, and other items of work clothing are not considered personal protective equipment for the purposes of this section and are not subject to the requirements of this section, although pesticide labeling may require that such work clothing be worn during some activities.

(iii) When "chemical-resistant" personal protective equipment is specified by the product labeling, it shall be made of material that allows no measurable movement of the pesticide being used through the material during use.

(iv) When "waterproof" personal protective equipment is specified by the product labeling, it shall be made of material that allows no measurable movement of water or aqueous solutions through the material during use.

(v) When a “chemical-resistant suit” is specified by the product labeling, it shall be a loose-fitting, one- or two-piece, chemical-resistant garment that covers, at a minimum, the entire body except head, hands, and feet.
(vi) When “coveralls” are specified by the product labeling, they shall be a loose-fitting, one- or two-piece garment, such as a cotton or cotton and polyester coverall, that covers, at a minimum, the entire body except head, hands, and feet. The pesticide product labeling may specify that the coveralls be worn over a layer of clothing. If a chemical-resistant suit is substituted for coveralls, it need not be worn over a layer of clothing.
(vii)(A) Gloves shall be of the type specified on the pesticide product labeling. Gloves made of leather, cotton, or other absorbent materials must not be worn for early-entry activities, unless gloves made of these materials are listed as acceptable for such use on the product labeling. If chemical-resistant gloves with sufficient durability and suppleness are not obtainable, leather gloves may be worn on top of chemical-resistant gloves. However, once leather gloves have been worn for this use, they shall not be worn thereafter for any other purpose, and they shall only be worn over chemical-resistant gloves.
(B) Separable glove liners may be worn beneath chemical-resistant gloves, unless the pesticide product labeling specifically prohibits their use. Separable glove liners are defined as separate glove-like hand coverings made of lightweight material, with or without fingers. Work gloves made from lightweight cotton or poly-type material are considered to be glove liners if worn beneath chemical-resistant gloves. Separable glove liners may not extend outside the chemical-resistant gloves under which they are worn. Chemical-resistant gloves with non-separable absorbent lining materials are prohibited.
(C) If used, separable glove liners must be discarded immediately after a total of no more than 10 hours of use or within 24 hours of when first put on, whichever comes first. The liners must be replaced immediately if directly contacted by pesticide. Used glove liners shall not be reused. Contaminated liners must be disposed of in accordance with any Federal, State, or local regulations.
(viii) When “chemical-resistant footwear” is specified by the product labeling, it shall be one of the following types of footwear: chemical-resistant shoes, chemical-resistant boots, or chemical-resistant shoe coverings worn over shoes or boots. If chemical-resistant footwear with sufficient durability and a tread appropriate for wear in rough terrain is not obtainable for workers, then leather boots may be worn in such terrain.
(ix) When “protective eyewear” is specified by the product labeling, it shall be one of the following types of eyewear: goggles; face shield; safety glasses with front, brow, and temple protection; or a full-face respirator.
(x) When “chemical-resistant headgear” is specified by the product labeling, it shall be either a chemical-resistant hood or a chemical-resistant hat with a wide brim.
(5) The agricultural employer shall assure that the worker, before entering the treated area, either has read the product labeling or has been informed, in a manner that the worker can understand, of all labeling requirements related to human hazards or precautions, first aid, symptoms of poisoning, personal protective equipment specified for early entry, and any other labeling requirements related to safe use.
(6) The agricultural employer shall assure that:

(i) Workers wear the personal protective equipment correctly for its intended purpose and use personal protective equipment according to manufacturer's instructions.
(ii) Before each day of use, all personal protective equipment is inspected for leaks, holes, tears, or worn places, and any damaged equipment is repaired or discarded.
(iii) Personal protective equipment that cannot be cleaned properly is disposed of in accordance with any applicable Federal, State, and local regulations.

(iv) All personal protective equipment is cleaned according to manufacturer's instructions or pesticide product labeling instructions before each day of reuse. In the absence of any such instructions, it shall be washed thoroughly in detergent and hot water.
(v) Before being stored, all clean personal protective equipment is dried thoroughly or is put in a well-ventilated place to dry.
(vi) Personal protective equipment contaminated with pesticides is kept separately and washed separately from any other clothing or laundry.
(vii) Any person who cleans or launders personal protective equipment is informed that such equipment may be contaminated with pesticides, of the potentially harmful effects of exposure to pesticides, and of the correct way(s) to handle and clean personal protective equipment and to protect themselves when handling equipment contaminated with pesticides.
(viii) All clean personal protective equipment is stored separately from personal clothing and apart from pesticide-contaminated areas.
(ix) Each worker is instructed how to put on, use, and remove the personal protective equipment and is informed about the importance of washing thoroughly after removing personal protective equipment.
(x) Each worker is instructed in the prevention, recognition, and first aid treatment of heat-related illness.
(xi) Workers have a clean place(s) away from pesticide-storage and pesticide-use areas for storing personal clothing not in use; putting on personal protective equipment at the start of any exposure period; and removing personal protective equipment at the end of any exposure period.
(7) When personal protective equipment is required by the labeling of any pesticide for early entry, the agricultural employer shall assure that no worker is allowed or directed to perform the early-entry activity without implementing, when appropriate, measures to prevent heat-related illness.
(8) During any early-entry activity, the agricultural employer shall provide a decontamination site in accordance with §170.150.
(9) The agricultural employer shall not allow or direct any worker to wear home or to take home personal protective equipment contaminated with pesticides.

(d) *Exception for an agricultural emergency.* (1) An "agricultural emergency" means a sudden occurrence or set of circumstances which the agricultural employer could not have anticipated and over which the agricultural employer has no control, and which requires entry into a treated area during a restricted-entry interval, when no alternative practices would prevent or mitigate a substantial economic loss. A substantial economic loss means a loss in profitability greater than that which would be expected based on the experience and fluctuations of crop yields in previous years. Only losses caused by the agricultural emergency specific to the affected site and geographic area are considered. The contribution of mismanagement cannot be considered in determining the loss.
(2) A worker may enter a treated area under a restricted-entry interval in an agricultural emergency to perform tasks, including hand labor tasks, necessary to mitigate the effects of the agricultural emergency, if the agricultural employer assures that all the following criteria are met:
(i) A State, Tribal, or Federal Agency having jurisdiction declares the existence of circumstances that could cause an agricultural emergency on that agricultural establishment.
(ii) The agricultural employer determines the agricultural establishment is subject to the circumstances declared under paragraph (d)(2)(i) of this section that result in an agricultural emergency meeting the criteria of paragraph (d)(1) of this section.
(iii) The requirements of paragraphs (c) (3) through (9) of this section are met.

(e) *Exception requiring Agency approval.* The Agency may, in accordance with paragraphs (e) (1) through (3) of this section, grant an exception from the requirements of this section. An exception may be withdrawn in accordance with paragraph (e)(6) of this section.

(1) *Exception requiring agency approval.* A request for an exception must be submitted to the Office of Pesticide Programs' Document Processing Desk at the appropriate address as set forth in 40 CFR 150.17(a) or (b) and must be accompanied by two copies of the following information:

(i) The name, address, and telephone number of the submitter.

(ii) The time period for which the exception is requested.

(iii) A description of the crop(s) and specific crop production task(s) for which the exception is requested. Such a description must include an explanation as to the necessity of applying pesticides of a type and at a frequency such that the restricted-entry interval would interfere with necessary and time-sensitive hand labor tasks for the period for which the exception is sought.

(iv) A description of the geographic area for which the exception is requested. If the exception request is for a limited geographic area, the explanation must include a description as to why the circumstances of exposure or economic impact resulting from the prohibition of routine hand labor tasks during the restricted-entry interval are unique to the geographic area named in the exception.

(v) An explanation as to why, for each requested crop-task combination, alternative practices would not be technically or financially viable. Such alternative practices might include: rescheduling the pesticide application or hand labor activity; using a non-chemical pest control alternative; using an alternative to the hand labor tasks, such as machine cultivation; or substituting a pesticide with a shorter restricted-entry interval. This information should include estimates or data on per acre revenue and cost of production for the crop and area for which the exception is requested. These estimates or data should include: the situation prior to implementation of this final rule, the situation after implementation of this final rule if the exception is not granted, the situation after implementation of this final rule if the exception is granted, and specific information on individual factors which cause differences in revenues and costs among the three situations.

(vi) A description or documentation of the safety and feasibility of such an exception, including, but not limited to, the feasibility of performing the necessary hand labor activity while wearing the personal protective equipment required for early entry for the pesticide(s) expected to be applied, the means of mitigating heat-related illness concerns, the period of time required daily per worker to perform the hand labor activity, any suggested methods of reducing the worker's exposure, and any other mitigating factors, such as the availability of running water for routine and emergency decontamination and mechanical devices that would reduce the workers' contact with the treated surfaces. The information should include the costs associated with early-entry, such as decontamination facilities, special information and training for the workers, heat stress avoidance procedures, and provision, inspection, cleaning, and maintenance of personal protective equipment. EPA will not grant exceptions where the costs of early entry equal or exceed the expected loss in value of crop yield or quality.

(2) *Notice of receipt.* (i) When a request for an exception is submitted to the Agency along with all of the information required in paragraph (e)(1) of this section, the Agency shall issue a notice in the FEDERAL REGISTER stating that an exception is being considered, describing the nature of the exception, and allowing at least 30 days for interested parties to comment.

(ii) If a request for an exception is submitted to the Agency without all of the information required in paragraph (e)(1) of this section, the Agency shall return the request to the submitter.

(3) *Exception decision.* EPA will publish in the FEDERAL REGISTER its decision whether to grant the request for exception. EPA will base its decision on whether the benefits of the exception outweigh the costs, including the value of the health risks attributable to the exception. If the exception is granted, the notice will state the nature of and reasons for the exception.

(4) *Presumptive denial.* (i) Except as provided in paragraph (e)(4)(ii) of this section, persons requesting an exception may assume that the exception has been denied if EPA has not issued its decision whether to grant the exception within 9 months from the comment-closure date specified in the FEDERAL REGISTER notice in which the Agency announced, in accordance with paragraph (e)(2) of this section, that it would consider the exception.

(ii) Persons requesting an exception may not assume that the request has been denied as provided by paragraph (e)(4)(i) of this section if the Agency has taken action to extend its review period for a specified time interval due to the complexity of the exception request or to the number of exception requests concurrently under Agency review. EPA shall state the reason(s) for the delay in issuing a decision on the exception request. A notice of such an action may be published in the FEDERAL REGISTER or persons who requested the exception may be directly notified of the action.

(5) *Agricultural employer duties.* When a worker enters a treated area during a restricted-entry interval under an exception granted under paragraph (e) of this section, the agricultural employer shall assure that the requirements of paragraphs (c) (3) through (9) of this section are met, unless the notice granting the exception specifically indicates otherwise.

(6) *Withdrawing an exception.* An exception may be withdrawn by the Agency at any time if the Agency receives poisoning information or other data that indicate that the health risks imposed by this early-entry exception are unacceptable or if the Agency receives other information that indicates that the exception is no longer necessary or prudent. If the Agency determines that an exception should be withdrawn, it will publish a notice in the FEDERAL REGISTER, stating the basis for its determination. Affected parties would then have 30 days to request a hearing on the Agency's determination. The exception, however, would be discontinued as of the date specified by EPA in the notice, which may include any of the 30-day period and the time required for any subsequent hearing process. Thereafter the Agency will decide whether to withdraw the exception and will publish a notice in the FEDERAL REGISTER stating its decision.

(7) *List of exceptions granted by EPA.* The following administrative exceptions from the requirements of this section have been granted by EPA. Each exception listed in paragraph (e)(7) of this section contains a reference to the FEDERAL REGISTER notice in which EPA has granted the exception and the effective dates of the exception. The terms and conditions of the exception appear in the referenced FEDERAL REGISTER notice.

(i) Exception to perform irrigation tasks under specified conditions published in the FEDERAL REGISTER of May 3, 1995.

(ii) Exceptions to perform limited contact tasks under specified conditions published in the FEDERAL REGISTER of May 3, 1995.

[57 FR 38151, Aug. 21, 1992, as amended at 59 FR 30264, June 10, 1994; 60 FR 21954, May 3, 1995; 62 FR 52003, Oct. 3, 1997; 69 FR 53346, Sept. 1, 2004; 71 FR 35546, June 21, 2006; 73 FR 75598, Dec. 12, 2008]

Workers May Designate a Representative Citation 1.g.

§170.305 Definitions

Designated representative means any persons designated in writing by a worker or handler to exercise a right of access on behalf of the worker or handler to request and obtain a copy of the pesticide application and hazard information required by §170.309(h) in accordance with §170.311(b) of this part.

§170.311 Display requirements for pesticide safety information and pesticide application and hazard information

(i) Any worker's or handler's designated representative may request access to or a copy of any information required to be retained for two years by §170.311(b)(6) on behalf of a worker or handler employed on the establishment during the period that the information was required to be displayed. The agricultural employer must provide access to or a copy of the requested information applicable to the worker's or handler's time of employment on the establishment within 15 days after receiving any such request, provided the request meets the requirements specified in §170.311(b)(9)(ii).

(ii) A request by a designated representative for access to or a copy of any pesticide application and/or hazard information must be in writing and must contain all of the following:

(A) The name of the worker or handler being represented.

(B) A description of the specific information being requested. The description should include the dates of employment of the worker or handler, the date or dates for which the records are requested, type of work conducted by the worker or handler (e.g., planting, harvesting, applying pesticides, mixing or loading pesticides) during the period for which the records are requested, and the specific application and/or hazard information requested.

(C) A written statement clearly designating the representative to request pesticide application and hazard information on the worker's or handler's behalf, bearing the worker's or handler's printed name and signature, the date of the designation, and the printed name and contact information for the designated representative.

(D) If the worker or handler requests that the pesticide application and/or the hazard information be sent, direction for where to send the information (e.g., mailing address or email address).

(iii) If the written request from a designated representative contains all of the necessary information specified in §170.313(b)(9)(ii), the employer must provide a copy of or access to all of the requested information applicable to the worker's or handler's time of employment on the establishment to the designated representative within 15 days of receiving the request.

(iv) Whenever a record has been previously provided without cost to a worker or handler or their designated representative, the agricultural employer may charge reasonable, non-discriminatory administrative costs (*i.e.,* search and copying expenses but not including overhead expenses) for a request by the designated representative for additional copies of the record.

Minimum Protection
Farmworkers labor in one of the nation's most dangerous industries and suffer the highest rates of chemical injuries and skin disorders. They have historically been among the least protected from on-the-job dangers.

A minimum protection in the standards is the ability of farmworkers across the country to obtain information they need for medical treatment, workers' compensation or to exercise their legal rights by having designated representatives request information on their behalf about the pesticides to which they are exposed while working.

These representatives can be co-workers, spouses, health care providers, union representatives, social workers or attorneys. In other industrial sectors, workers exposed to toxic substances or harmful physical agents have the right of access to relevant exposure records through their designated representatives.

Employee Rights:
A worker may designate a representative to request, on their behalf, pesticide application and hazard information.

To personally receive information about pesticides to which he or she may be exposed.

For his or her physician or employee representative to receive information about pesticides to which he or she may be exposed.

To be protected against retaliatory action due to the exercise of any of these rights.

How to recognize and understand the meaning of the posted warning signs used for notifying workers of restrictions on entering pesticide treated areas on the establishment.

§170.409 Oral and posted notification of worker entry restrictions.

(a) *General Requirement.* The agricultural employer must notify workers of all entry restrictions required by §§170.405 and 170.407 in accordance with this section.

(1*) Type of notification required*—(i) *Double notification.* If the pesticide product labeling has a statement requiring both the posting of treated areas and oral notification to workers, the agricultural employer must post signs in accordance with paragraph (b) of this section and must also provide oral notification of the application to workers in accordance with paragraph (c) of this section.

(ii) *Outdoor production areas subject to restricted-entry intervals greater than 48 hours.* If a pesticide with product labeling that requires a restricted-entry interval greater than 48 hours is applied to an outdoor production area, the agricultural employer must notify workers of the application by posting warning signs in accordance with paragraph (b) of this section.

(iii) *Outdoor production areas subject to restricted-entry intervals equal to or less than 48 hours.* If a pesticide with product labeling that requires a restricted-entry interval equal to or less than 48 hours is applied to an outdoor production area, the agricultural employer must notify workers of the application either by posting warning signs in accordance with paragraph (b) of this section or by providing workers with an oral warning in accordance with paragraph (c) of this section.

(iv) *Enclosed space production areas subject to restricted-entry intervals greater than four hours.* If a pesticide with product labeling that requires a restricted-entry interval greater than four hours is applied to an enclosed space production area, the agricultural employer must notify workers of the application by posting warning signs in accordance with paragraph (b) of this section.

(v) *Enclosed space production areas subject to restricted-entry intervals equal to or less than four hours.* If a pesticide with product labeling that requires a restricted-entry interval equal to or less than four hours is applied to an enclosed space production area, the agricultural employer must notify workers of the application either by posting warning signs in accordance with paragraph (b) of this section or by providing workers with an oral warning in accordance with paragraph (c) of this section.

(2) *Exceptions.* Notification does not need to be given to a worker if the agricultural employer can ensure that one of the following is met:

(i) From the start of the application in an enclosed space production area until the end of any restricted-entry interval, the worker will not enter any part of the entire enclosed structure or space.

(ii) From the start of the application to an outdoor production area until the end of any restricted-entry interval, the worker will not enter, work in, remain in, or pass on foot through the treated area or any area within ¼ mile of the treated area on the agricultural establishment.

(iii) The worker was involved in the application of the pesticide as a handler, and is aware of all information required by paragraph (c)(1) of this section.

(b) *Requirements for posted warning signs.* If notification by posted warning signs is required pursuant to paragraph (a) of this section, the agricultural employer must, unless otherwise prescribed by the label, ensure that all warning signs meet the requirements of this paragraph. When several contiguous areas are to be treated with pesticides on a rotating or sequential basis, the entire area may be posted. Worker entry is prohibited for the entire area while the signs are posted, except for entry permitted by §170.603 of this part.

(1) *General.* The warning signs must meet all of the following requirements:
(i) Be one of the three sizes specified in paragraph (b)(3) of this section and comply with the posting placement and spacing requirements applicable to that sign size.
(ii) Be posted prior to but no earlier than 24 hours before the scheduled application of the pesticide.
(iii) Remain posted throughout the application and any restricted-entry interval.
(iv) Be removed or covered within three days after the end of the application or any restricted-entry interval, whichever is later, except that signs may remain posted after the restricted-entry interval has expired as long as all of the following conditions are met:
(A) The agricultural employer instructs any workers on the establishment that may come within ¼ mile of the treated area not to enter that treated area while the signs are posted.
(B) The agricultural employer ensures that workers do not enter the treated area while the signs remain posted, other than entry permitted by §170.603 of this part.
(v) Remain visible and legible during the time they are required to be posted.

(2) *Content.* (i) The warning sign must have a white background. The words “DANGER” and “PELIGRO,” plus “PESTICIDES” and “PESTICIDAS,” must be at the top of the sign, and the words “KEEP OUT” and “NO ENTRE” must be at the bottom of the sign. Letters for all words must be clearly legible. A circle containing an upraised hand on the left and a stern face on the right must be near the center of the sign. The inside of the circle must be red, except that the hand and a large portion of the face must be in white. The length of the hand must be at least twice the height of the smallest letters. The length of the face must be only slightly smaller than the hand. Additional information such as the name of the pesticide and the date of application may appear on the warning sign if it does not detract from the size and appearance of the sign or change the meaning of the required information. An example of a warning sign meeting these requirements, other than the size and color requirements, follows:

(ii) The agricultural employer may replace the Spanish language portion of the warning sign with equivalent terms in an alternative non-English language if that alternative language is the language read by the largest group of workers at that agricultural establishment who do not read English. The alternative language sign must be in the same format as the original sign and conform to all other requirements of paragraph (b)(2)(i) of this section.

(3) *Size and posting.* (i) The standard sign must be at least 14 inches by 16 inches with letters at least one inch in height.

(ii) When posting an outdoor production area using the standard sign, the signs must be visible from all reasonably expected points of worker entry to the treated area, including at least each access road, each border with any worker housing area within 100 feet of the treated area and each footpath and other walking route that enters the treated area. Where there are no reasonably expected points of worker entry, signs must be posted in the corners of the treated area or in any other location affording maximum visibility.

(iii) When posting an enclosed space production area using the standard sign and the entire structure or space is subject to the labeling-specified restricted-entry interval and the post-application entry restrictions specified in §170.407, the signs must be posted so they are visible from all reasonably expected points of worker entry to the structure or space. When posting treated areas in enclosed space production using the standard sign and the treated area only comprises a subsection of the structure or space, the signs must be posted so they are visible from all reasonably expected points of worker entry to the treated area including each aisle or other walking route that enters the treated area. Where there are no reasonably expected points of worker entry to the treated area, signs must be posted in the corners of the treated area or in any other location affording maximum visibility.

(iv) If a smaller warning sign is used with “DANGER” and “PELIGRO” in letters at least 7/8 inch in height and the remaining letters at least 1/2 inch in height and a red circle at least three inches in diameter containing an upraised hand and a stern face, the signs must be posted no farther than 50 feet apart around the perimeter of the treated area in addition to the locations specified in paragraphs (b)(3)(ii) or (b)(3)(iii) of this section.

(v) If a smaller sign is used with “DANGER” and “PELIGRO” in letters at least 7/16 inch in height and the remaining letters at least 1/4 inch in height and a red circle at least one and a half inches in diameter containing an upraised hand and a stern face, the signs must be posted no farther than 25 feet apart around the perimeter of the treated area in addition to the locations specified in paragraphs (b)(3)(ii) or (b)(3)(iii) of this section.

(vi) A sign with “DANGER” and “PELIGRO” in letters less than 7/16 inch in height or with any words in letters less than 1/4 inch in height or a red circle smaller than one and a half inches in diameter containing an upraised hand and a stern face will not satisfy the requirements of the rule.

(c) *Oral warnings—Requirement.* If oral notification is required pursuant to paragraph (a) of this section, the agricultural employer must provide oral warnings to workers in a manner that the workers can understand. If a worker will be on the establishment when an application begins, the warning must be given before the application begins. If a worker arrives on the establishment while an application is taking place or a restricted-entry interval for a pesticide application is in effect, the warning must be given at the beginning of the worker's work period. The warning must include all of the following:

(1) The location(s) and description of any treated area(s) subject to the entry restrictions during and after application specified in §§170.405 and 170.407.

(2) The dates and times during which entry is restricted in any treated area(s) subject to the entry restrictions during and after application specified in §§170.405 and 170.407.

(3) Instructions not to enter the treated area or an application exclusion zone during application, and that entry to the treated area is not allowed until the restricted-entry interval has expired and all treated area warning signs have been removed or covered, except for entry permitted by §170.603 of this part.

Greenhouses (*Some States have modified this to Enclosed Growing Facilities*)
All greenhouse applications must be posted with warning signs. The standard 14-by-16- inch sign may be used or you can use smaller signs. If you use smaller signs, you may have to use more of them.

With smaller signs, follow the specific posting distance requirements, depending on the size of the lettering and symbol on the sign.

In greenhouses, the signs must be posted to be visible from all usual points where workers enter including each aisle or other walking route. When the treated area has no usual points of worker entry, signs must be posted in the corners of the treated area or in any other location with maximum visibility.

Outdoor Grow Operations
Whether a pesticide application in an outdoor grow area must be posted with warning signs depends on what the label requires:

- If the pesticide label requires both posting and oral notification, then you need to do both.
- For all other pesticides that require a warning, you have the option of either posting or providing oral notification.

Applications to outdoor plants must use the standard 14” by 16” sign. The signs must be visible from all usual points of worker entry, including at least each access road, footpath or other walking route that enters the treated area. When there are no usual points of worker entry, signs must be posted in the corners of the treated area or in any other location affording maximum visibility.

Whether for a greenhouse application or an outdoor grow application, signs must:

- Be posted no sooner than twenty-four hours before the scheduled application of the pesticide.
- Remain posted throughout the application and any restricted-entry interval.
- Be removed within three days after the end of the application and any restricted-entry interval.

Oral warnings must provide:

- Location and description of the treated area.
- Time during which entry is restricted.
- Instructions to not enter the treated area until the restricted-entry interval has expired.

This course contains EPA’s federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA’s regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

Entry Restrictions in the Treated Area Citation 3

Only properly trained pesticide handlers who are wearing the required PPE may be in the treated area ("entry restricted area" for greenhouses) while the pesticide is being applied. In most cases, the "entry-restricted area" and the "treated area" are the same thing. For applications to greenhouses, however, the entry-restricted area may be larger than the treated area.

The restricted-entry interval (REI) begins immediately after the pesticide application is complete. During the REI, no worker is allowed to enter the entry-restricted area except under very limited conditions:

1. No early-entry by any worker is allowed until:
   a. At least four hours after the application is complete.
   b. All applicable ventilation criteria in WAC 16-233-115(3)(c) have been met.
   c. Any inhalation exposure level listed in the labeling has been reached.

2. Once the above three criteria have been met, early-entry workers are allowed into the entry-restricted area for "no-contact" activities and "short-term" activities as described below. ***No hand labor is allowed by early-entry workers in either case.***
   • No-Contact Activities: Workers will have no contact with anything that has been treated with the pesticide, including but not limited to, soil, water, air, or surfaces of plants. Early-entry workers under the no-contact exception do not need to wear the label-specified PPE for early-entry and they do not need decontamination supplies as do other early-entry workers.
   • Short-term Activities: A worker can spend no more than one hour in a 24-hour period conducting short-term activities.

Workers must wear all of the PPE specified on the label for early-entry and the decontamination supplies for early-entry workers must be readily available nearby. Before an early-entry worker enters the treated area under an REI, the employer must make sure they have either read the pesticide label, or that all hazards, precautions, poisoning symptoms, first-aid, and required personal protective equipment have been explained to them.

Beginning in January 2017, they also must be informed about the specifics of the pesticide application and the conditions of early-entry.

Once the REI has expired, workers are free to enter the entry-restricted/treated area. Workers may do hand labor or other tasks and they do not need to wear PPE. However, if workers will have contact with any treated surface, decontamination supplies must be readily available nearby -- for either seven days or 30 days, depending on the REI.

Application Exclusion Zone (AEZ)

The AEZ is an exclusion zone that surrounds the application equipment in a 360-degree radius. High drift applications such as air blast sprayers, aerial applications, fumigants, mist and fogging will need a 100 foot "bubble" where everyone is excluded except for handlers that have the proper PPE and training to work inside that bubble.

Low drift applications will need a 25-foot bubble. If someone is in that AEZ the handler must suspend application in that area until they leave that area.

NOTE: *As of January 2017, all outdoor applications will have an "application exclusion zone" of 0 – 100 feet. The size of the zone depends on the type of application equipment used. The application exclusion zone extends beyond the treatment area. Applicators will be required to stop the application if anyone enters the exclusion zone.*

Entry Restrictions

• Only properly trained pesticide handlers who are wearing the required PPE may be in the entry restricted/treated area during the application.
• After the application is complete, no worker may enter until:

- ✓ At least four hours.
- ✓ The ventilation criteria in rule has been met.
- ✓ Any inhalation exposure level listed in the labeling has been reached.

• Once the above three criteria are met, early-entry is allowed. Workers who are properly trained and equipped with the required PPE may enter the restricted entry/treated area to perform "no contact" and "short-term" activities. No PPE is required for no-contact activities. No hand labor is allowed in either case.
• Decontamination supplies must be provided and readily accessible nearby for early-entry workers, except those workers entering under the "no contact" exception.
• After the REI has expired, workers have unlimited access to the treated area and no PPE is required.

Decontamination supplies must still be provided for either seven days or 30 days, depending on the label requirements.

Decontamination Supplies Summary
Pesticide handlers still need three gallons of water, soap and paper towels at the mix and load site, within a quarter mile of the application area and where PPE is taken off. If they are working with a product requiring eye protection they must have "immediate "access to at least a pint of eye wash or fresh water.

Handlers need an eye wash system at the mix and load site capable of delivering .4 gallons of water for 15 minutes or 6 gallons of water able to flow gently for 15 minutes. This does **Not** have to be a fancy system; it can be a hose attached to a faucet. A change of clothes for handlers is also required.

Although handlers and workers need to have access to the required decontamination supplies they can in emergency situations make use of natural waters that are close by in addition to the required decontamination supplies.

Workers need to have access to at least a gallon of wash water, soap and paper towels within a quarter of a mile of the crop area that they are working in.

Workers need 1 gallon and Handlers need 3 gallons of water.

§170.110 Restrictions Associated with Pesticide Applications

(a) *Farms and forests.* During the application of any pesticide on a farm or in a forest, the agricultural employer shall not allow or direct any person, other than an appropriately trained and equipped handler, to enter or to remain in the treated area.

(b) *Nurseries.* In a nursery, during any pesticide application described in column A of Table 1 of this paragraph, the agricultural employer shall not allow or direct any person, other than an appropriately trained and equipped handler, to enter or to remain in the area specified in column B of Table 1 of this paragraph. After the application is completed, until the end of any restricted-entry interval, the entry-restricted area is the treated area.

TABLE 1—ENTRY-RESTRICTED AREAS IN NURSERIES DURING PESTICIDE APPLICATIONS

A. During Application of a Pesticide:	B. Workers are Prohibited in:
(1)(a) Applied:	Treated area plus 100 feet in all directions on the nursery
(i) Aerially, or	
(ii) In an upward direction, or	
(iii) Using a spray pressure greater than 150 psi, or	
(b) Applied as a:	
(i) Fumigant, or	
(ii) Smoke, or	
(iii) Mist, or	
(iv) Fog, or	
(v) Aerosol.	
(2)(a) Applied downward using:	Treated are plus 25 feet in all directions on the nursery
(i) A height of greater than 12 inches from the planting medium, or	
(ii) A fine spray, or	
(iii) A spray pressure greater than 40 psi and less than 150 psi.	
(b) Not as in 1 or 2(a) above but for which a respiratory protection device is required for application by the product labeling.	
(3) Applied otherwise.	Treated area

(c) *Greenhouses.* (1) When a pesticide application described in column A of Table 2 under paragraph (c)(4) of this section takes place in a greenhouse, the agricultural employer shall not allow or direct any person, other than an appropriately trained and equipped handler, to enter or to remain in the area specified in column B of Table 2 until the time specified in column C of Table 2 has expired.

(2) After the time specified in column C of Table 2 under paragraph (c)(4) of this section has expired, until the expiration of any restricted-entry interval, the agricultural employer shall not

allow or direct any worker to enter or to remain in the treated area as specified in column D of Table 2 under paragraph (c)(4) of this section, except as provided in §170.112.

(3) When column C of Table 2 under paragraph (c)(4) of this section specifies that ventilation criteria must be met, ventilation shall continue until the air concentration is measured to be equal to or less than the inhalation exposure level the labeling requires to be achieved. If no inhalation exposure level is listed on the labeling, ventilation shall continue until after:

(i) Ten air exchanges are completed; or

(ii) Two hours of ventilation using fans or other mechanical ventilating systems; or

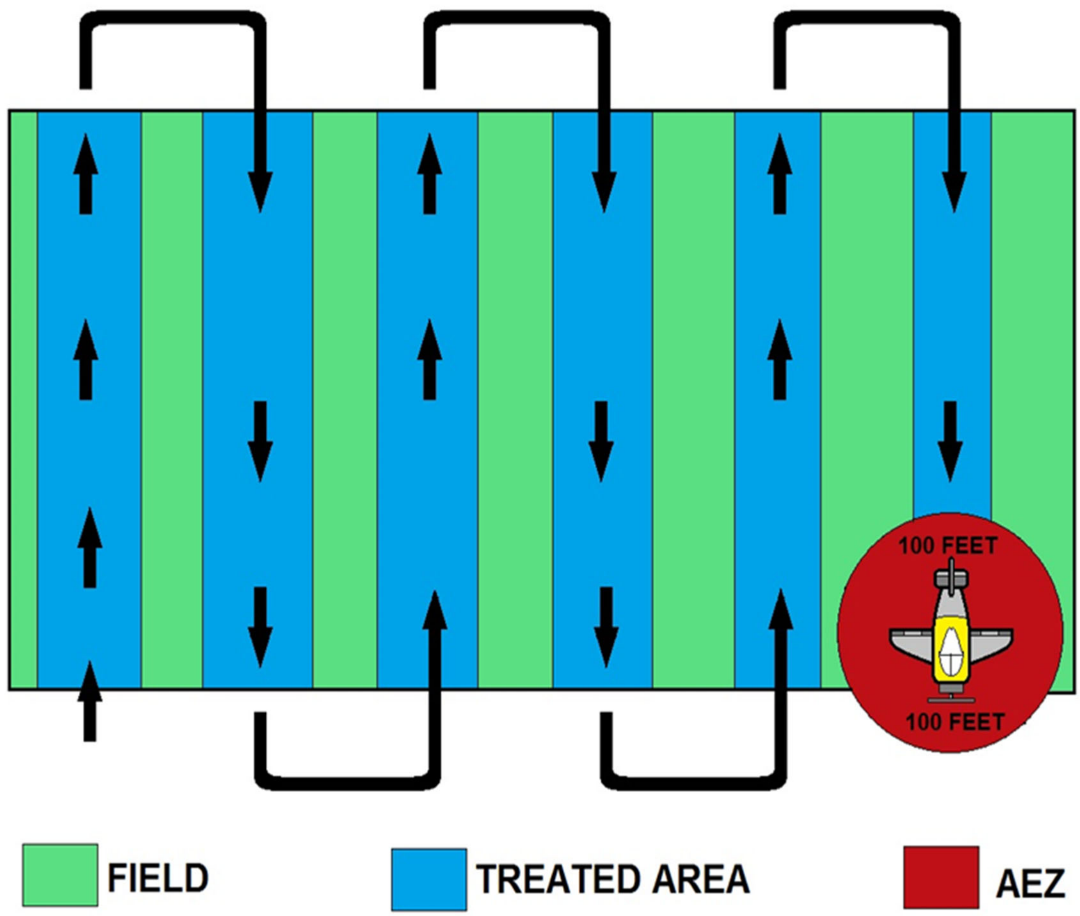
(iii) Four hours of ventilation using vents, windows or other passive ventilation; or

(iv) Eleven hours with no ventilation followed by 1 hour of mechanical ventilation; or

(v) Eleven hours with no ventilation followed by 2 hours of passive ventilation; or

(vi) Twenty-four hours with no ventilation.

(4) The following Table 2 applies to paragraphs (c) (1), (2), and (3) of this section.

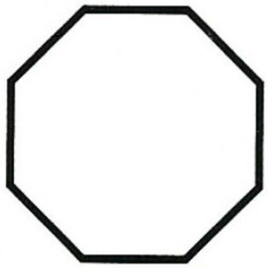
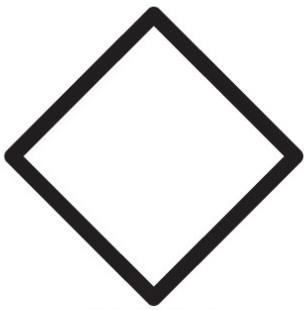
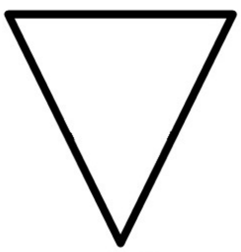


APPLICATION EXCLUSION ZONE (AEZ) - OUTDOOR PRODUCTION

(100 Feet for Aerial, Airblast, Fumigant, Smoke, Mist and Fog Applications, as well as Spray Applications using very Fine OR Fine Droplet sizes)

TABLE 2—GREENHOUSE ENTRY RESTRICTIONS ASSOCIATED WITH PESTICIDE APPLICATIONS

A. When a Pesticide is Applied:	**B. Workers are Prohibited in:**	**C. Until:**	**D. After the Expiration of Time in Column C Until the Restricted-Entry Interval Expires, the Entry-Restricted Area is:**
(1) As a fumigant	Entire greenhouse plus any adjacent structure that cannot be sealed off from the treated area	The ventilation criteria of paragraph (c)(3) of this section are met	No entry restrictions after criteria in column C are met
(2) As a	Entire enclosed area	The ventilation criteria of paragraph (c)(3) of this section are met	Entire enclosed area is the treated area
(i) Smoke, or			
(ii) Mist, or			
(iii) Fog, or			
(iv) Aerosol			
(3) Not in 1 or 2 above, and for which a respiratory protection device is required for application by the product labeling	Entire enclosed area	The ventilation criteria of paragraph (c)(3) of this section are met	Treated area
(4) Not in 1, 2, or 3 above, and:	Treated area plus 25 feet in all directions in the enclosed area	Application is complete	Treated area
(i) From a height of greater than 12 in. from the planting medium, or			
(ii) As a fine spray, or			
(iii) Using a spray pressure greater than 40 psi			
(5) Otherwise	Treated area	Application is complete	Treated area

SYMBOL	SIGNAL WORD		SYMBOL
	DEGREE OF HAZARD	**NATURE OF PRIMARY HAZARD**	
 DANGER	**DANGER** LD_{50} Less than 500 mg/kg HIGH TOXICITY REQUIRES: Goggles Respirator Gloves Skin Protection Avoid the Fumes and Mist	**POISON**	
 WARNING	**WARNING** LD_{50} 500 - 1000 mg/kg MODERATE TOXICITY REQUIRES: Goggles Gloves Skin Protection Avoid the Fumes and Mist	**CORROSIVE**	
		FLAMMABLE	
 CAUTION	**CAUTION** LD_{50} 1000 - 2500 mg/kg LOW TOXICITY REQUIRES: Gloves Skin Protection Avoid the Fumes and Mist	**EXPLOSIVE**	

GRAPH DEPICTING DEGREE OF RISK & HAZARD SYMBOLS RELATED TO PESTICIDES

§170.112 Entry Restrictions

(a) *General restrictions.* (1) After the application of any pesticide on an agricultural establishment, the agricultural employer shall not allow or direct any worker to enter or to remain in the treated area before the restricted-entry interval specified on the pesticide labeling has expired, except as provided in this section.
(2) Entry-restricted areas in greenhouses are specified in column D in table 2 under §170.110(c)(4).
(3) When two or more pesticides are applied at the same time, the restricted-entry interval shall be the longest of the applicable intervals.
(4) The agricultural employer shall assure that any worker who enters a treated area under a restricted-entry interval as permitted by paragraphs (c), (d), and (e) of this section uses the personal protective equipment specified in the product labeling for early-entry workers and follows any other requirements on the pesticide labeling regarding early entry.
(b) *Exception for activities with no contact.* A worker may enter a treated area during a restricted-entry interval if the agricultural employer assures that both of the following are met:
(1) The worker will have no contact with anything that has been treated with the pesticide to which the restricted-entry interval applies, including, but not limited to, soil, water, air, or surfaces of plants; and
(2) No such entry is allowed until any inhalation exposure level listed in the labeling has been reached or any ventilation criteria established by §170.110(c)(3) or in the labeling have been met.
(c) *Exception for short-term activities.* A worker may enter a treated area during a restricted-entry interval for short-term activities if the agricultural employer assures that the following requirements are met:
(1) No hand labor activity is performed.
(2) The time in treated areas under a restricted-entry interval for any worker does not exceed 1 hour in any 24-hour period.
(3) No such entry is allowed for the first 4 hours following the end of the application, and no such entry is allowed thereafter until any inhalation exposure level listed in the labeling has been reached or any ventilation criteria established by §170.110(c)(3) or in the labeling have been met.
(4) The personal protective equipment specified on the product labeling for early entry is provided to the worker. Such personal protective equipment shall conform to the following standards:
(i) Personal protective equipment (PPE) means devices and apparel that are worn to protect the body from contact with pesticides or pesticide residues, including, but not limited to, coveralls, chemical-resistant suits, chemical-resistant gloves, chemical-resistant footwear, respiratory protection devices, chemical-resistant aprons, chemical-resistant headgear, and protective eyewear.
(ii) Long-sleeved shirts, short-sleeved shirts, long pants, short pants, shoes, socks, and other items of work clothing are not considered personal protective equipment for the purposes of this section and are not subject to the requirements of this section, although pesticide labeling may require that such work clothing be worn during some activities.
(iii) When “chemical-resistant” personal protective equipment is specified by the product labeling, it shall be made of material that allows no measurable movement of the pesticide being used through the material during use.
(iv) When “waterproof” personal protective equipment is specified by the product labeling, it shall be made of material that allows no measurable movement of water or aqueous solutions through the material during use.

(v) When a “chemical-resistant suit” is specified by the product labeling, it shall be a loose-fitting, one- or two-piece, chemical-resistant garment that covers, at a minimum, the entire body except head, hands, and feet.

(vi) When “coveralls” are specified by the product labeling, they shall be a loose-fitting, one- or two-piece garment, such as a cotton or cotton and polyester coverall, that covers, at a minimum, the entire body except head, hands, and feet. The pesticide product labeling may specify that the coveralls be worn over a layer of clothing. If a chemical-resistant suit is substituted for coveralls, it need not be worn over a layer of clothing.

(vii)(A) Gloves shall be of the type specified on the pesticide product labeling. Gloves made of leather, cotton, or other absorbent materials must not be worn for early-entry activities, unless gloves made of these materials are listed as acceptable for such use on the product labeling. If chemical-resistant gloves with sufficient durability and suppleness are not obtainable, leather gloves may be worn on top of chemical-resistant gloves. However, once leather gloves have been worn for this use, they shall not be worn thereafter for any other purpose, and they shall only be worn over chemical-resistant gloves.

(B) Separable glove liners may be worn beneath chemical-resistant gloves, unless the pesticide product labeling specifically prohibits their use. Separable glove liners are defined as separate glove-like hand coverings made of lightweight material, with or without fingers. Work gloves made from lightweight cotton or poly-type material are considered to be glove liners if worn beneath chemical-resistant gloves. Separable glove liners may not extend outside the chemical-resistant gloves under which they are worn. Chemical-resistant gloves with non-separable absorbent lining materials are prohibited.

(C) If used, separable glove liners must be discarded immediately after a total of no more than 10 hours of use or within 24 hours of when first put on, whichever comes first. The liners must be replaced immediately if directly contacted by pesticide. Used glove liners shall not be reused. Contaminated liners must be disposed of in accordance with any Federal, State, or local regulations.

(viii) When “chemical-resistant footwear” is specified by the product labeling, it shall be one of the following types of footwear: chemical-resistant shoes, chemical-resistant boots, or chemical-resistant shoe coverings worn over shoes or boots. If chemical-resistant footwear with sufficient durability and a tread appropriate for wear in rough terrain is not obtainable for workers, then leather boots may be worn in such terrain.

(ix) When “protective eyewear” is specified by the product labeling, it shall be one of the following types of eyewear: goggles; face shield; safety glasses with front, brow, and temple protection; or a full-face respirator.

(x) When “chemical-resistant headgear” is specified by the product labeling, it shall be either a chemical-resistant hood or a chemical-resistant hat with a wide brim.

(5) The agricultural employer shall assure that the worker, before entering the treated area, either has read the product labeling or has been informed, in a manner that the worker can understand, of all labeling requirements related to human hazards or precautions, first aid, symptoms of poisoning, personal protective equipment specified for early entry, and any other labeling requirements related to safe use.

(6) The agricultural employer shall assure that:

(i) Workers wear the personal protective equipment correctly for its intended purpose and use personal protective equipment according to manufacturer's instructions.

(ii) Before each day of use, all personal protective equipment is inspected for leaks, holes, tears, or worn places, and any damaged equipment is repaired or discarded.

(iii) Personal protective equipment that cannot be cleaned properly is disposed of in accordance with any applicable Federal, State, and local regulations.

(iv) All personal protective equipment is cleaned according to manufacturer's instructions or pesticide product labeling instructions before each day of reuse. In the absence of any such instructions, it shall be washed thoroughly in detergent and hot water.
(v) Before being stored, all clean personal protective equipment is dried thoroughly or is put in a well-ventilated place to dry.
(vi) Personal protective equipment contaminated with pesticides is kept separately and washed separately from any other clothing or laundry.
(vii) Any person who cleans or launders personal protective equipment is informed that such equipment may be contaminated with pesticides, of the potentially harmful effects of exposure to pesticides, and of the correct way(s) to handle and clean personal protective equipment and to protect themselves when handling equipment contaminated with pesticides.
(viii) All clean personal protective equipment is stored separately from personal clothing and apart from pesticide-contaminated areas.
(ix) Each worker is instructed how to put on, use, and remove the personal protective equipment and is informed about the importance of washing thoroughly after removing personal protective equipment.
(x) Each worker is instructed in the prevention, recognition, and first aid treatment of heat-related illness.
(xi) Workers have a clean place(s) away from pesticide-storage and pesticide-use areas for storing personal clothing not in use; putting on personal protective equipment at the start of any exposure period; and removing personal protective equipment at the end of any exposure period.
(7) When personal protective equipment is required by the labeling of any pesticide for early entry, the agricultural employer shall assure that no worker is allowed or directed to perform the early-entry activity without implementing, when appropriate, measures to prevent heat-related illness.
(8) During any early-entry activity, the agricultural employer shall provide a decontamination site in accordance with §170.150.
(9) The agricultural employer shall not allow or direct any worker to wear home or to take home personal protective equipment contaminated with pesticides.

(d) *Exception for an agricultural emergency.* (1) An “agricultural emergency” means a sudden occurrence or set of circumstances which the agricultural employer could not have anticipated and over which the agricultural employer has no control, and which requires entry into a treated area during a restricted-entry interval, when no alternative practices would prevent or mitigate a substantial economic loss. A substantial economic loss means a loss in profitability greater than that which would be expected based on the experience and fluctuations of crop yields in previous years. Only losses caused by the agricultural emergency specific to the affected site and geographic area are considered. The contribution of mismanagement cannot be considered in determining the loss.

(2) A worker may enter a treated area under a restricted-entry interval in an agricultural emergency to perform tasks, including hand labor tasks, necessary to mitigate the effects of the agricultural emergency, if the agricultural employer assures that all the following criteria are met:
(i) A State, Tribal, or Federal Agency having jurisdiction declares the existence of circumstances that could cause an agricultural emergency on that agricultural establishment.

(ii) The agricultural employer determines the agricultural establishment is subject to the circumstances declared under paragraph (d)(2)(i) of this section that result in an agricultural emergency meeting the criteria of paragraph (d)(1) of this section.
(iii) The requirements of paragraphs (c) (3) through (9) of this section are met.
(e) *Exception requiring Agency approval.* The Agency may, in accordance with paragraphs (e) (1) through (3) of this section, grant an exception from the requirements of this section. An exception may be withdrawn in accordance with paragraph (e)(6) of this section.
(1) *Exception requiring agency approval.* A request for an exception must be submitted to the Office of Pesticide Programs' Document Processing Desk at the appropriate address as set forth in 40 CFR 150.17(a) or (b) and must be accompanied by two copies of the following information:
(i) The name, address, and telephone number of the submitter.
(ii) The time period for which the exception is requested.
(iii) A description of the crop(s) and specific crop production task(s) for which the exception is requested. Such a description must include an explanation as to the necessity of applying pesticides of a type and at a frequency such that the restricted-entry interval would interfere with necessary and time-sensitive hand labor tasks for the period for which the exception is sought.
(iv) A description of the geographic area for which the exception is requested. If the exception request is for a limited geographic area, the explanation must include a description as to why the circumstances of exposure or economic impact resulting from the prohibition of routine hand labor tasks during the restricted-entry interval are unique to the geographic area named in the exception.
(v) An explanation as to why, for each requested crop-task combination, alternative practices would not be technically or financially viable. Such alternative practices might include: rescheduling the pesticide application or hand labor activity; using a non-chemical pest control alternative; using an alternative to the hand labor tasks, such as machine cultivation; or substituting a pesticide with a shorter restricted-entry interval. This information should include estimates or data on per acre revenue and cost of production for the crop and area for which the exception is requested. These estimates or data should include: the situation prior to implementation of this final rule, the situation after implementation of this final rule if the exception is not granted, the situation after implementation of this final rule if the exception is granted, and specific information on individual factors which cause differences in revenues and costs among the three situations.
(vi) A description or documentation of the safety and feasibility of such an exception, including, but not limited to, the feasibility of performing the necessary hand labor activity while wearing the personal protective equipment required for early entry for the pesticide(s) expected to be applied, the means of mitigating heat-related illness concerns, the period of time required daily per worker to perform the hand labor activity, any suggested methods of reducing the worker's exposure, and any other mitigating factors, such as the availability of running water for routine and emergency decontamination and mechanical devices that would reduce the workers' contact with the treated surfaces. The information should include the costs associated with early-entry, such as decontamination facilities, special information and training for the workers, heat stress avoidance procedures, and provision, inspection, cleaning, and maintenance of personal protective equipment. EPA will not grant exceptions where the costs of early entry equal or exceed the expected loss in value of crop yield or quality.

(2) *Notice of receipt.* (i) When a request for an exception is submitted to the Agency along with all of the information required in paragraph (e)(1) of this section, the Agency shall issue a notice in the FEDERAL REGISTER stating that an exception is being considered, describing the nature of the exception, and allowing at least 30 days for interested parties to comment.

(ii) If a request for an exception is submitted to the Agency without all of the information required in paragraph (e)(1) of this section, the Agency shall return the request to the submitter.

(3) *Exception decision.* EPA will publish in the FEDERAL REGISTER its decision whether to grant the request for exception. EPA will base its decision on whether the benefits of the exception outweigh the costs, including the value of the health risks attributable to the exception. If the exception is granted, the notice will state the nature of and reasons for the exception.

(4) *Presumptive denial.* (i) Except as provided in paragraph (e)(4)(ii) of this section, persons requesting an exception may assume that the exception has been denied if EPA has not issued its decision whether to grant the exception within 9 months from the comment-closure date specified in the FEDERAL REGISTER notice in which the Agency announced, in accordance with paragraph (e)(2) of this section, that it would consider the exception.

(ii) Persons requesting an exception may not assume that the request has been denied as provided by paragraph (e)(4)(i) of this section if the Agency has taken action to extend its review period for a specified time interval due to the complexity of the exception request or to the number of exception requests concurrently under Agency review. EPA shall state the reason(s) for the delay in issuing a decision on the exception request. A notice of such an action may be published in the FEDERAL REGISTER or persons who requested the exception may be directly notified of the action.

(5) *Agricultural employer duties.* When a worker enters a treated area during a restricted-entry interval under an exception granted under paragraph (e) of this section, the agricultural employer shall assure that the requirements of paragraphs (c) (3) through (9) of this section are met, unless the notice granting the exception specifically indicates otherwise.

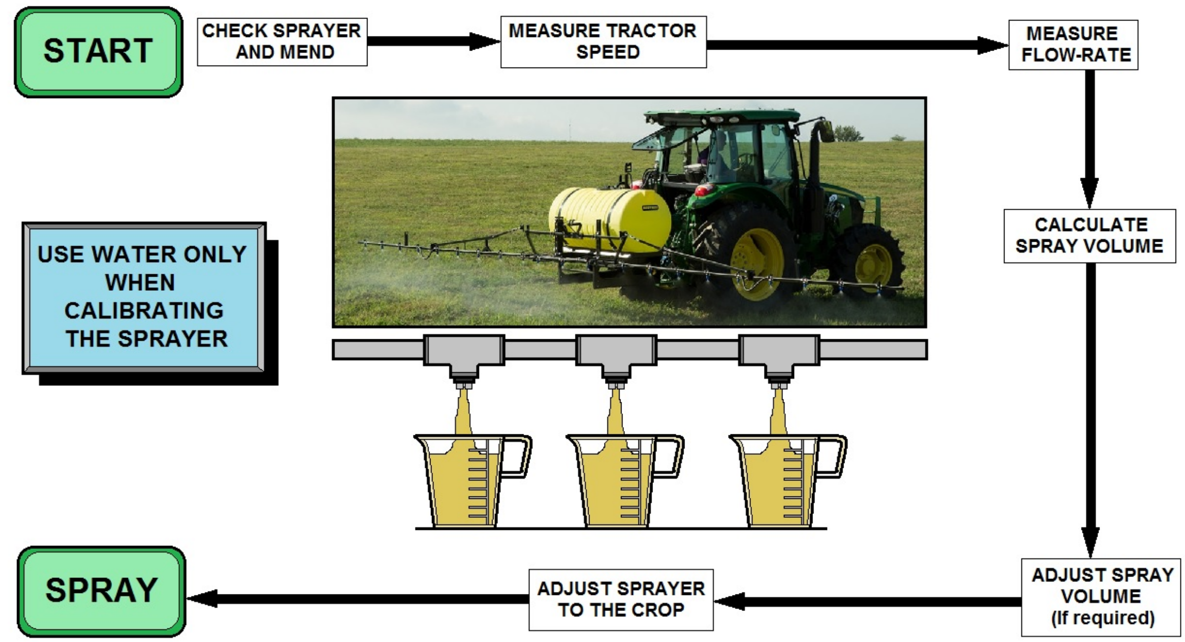
(6) *Withdrawing an exception.* An exception may be withdrawn by the Agency at any time if the Agency receives poisoning information or other data that indicate that the health risks imposed by this early-entry exception are unacceptable or if the Agency receives other information that indicates that the exception is no longer necessary or prudent. If the Agency determines that an exception should be withdrawn, it will publish a notice in the FEDERAL REGISTER, stating the basis for its determination. Affected parties would then have 30 days to request a hearing on the Agency's determination. The exception, however, would be discontinued as of the date specified by EPA in the notice, which may include any of the 30-day period and the time required for any subsequent hearing process. Thereafter the Agency will decide whether to withdraw the exception and will publish a notice in the FEDERAL REGISTER stating its decision.

(7) *List of exceptions granted by EPA.* The following administrative exceptions from the requirements of this section have been granted by EPA. Each exception listed in paragraph (e)(7) of this section contains a reference to the FEDERAL REGISTER notice in which EPA has granted the exception and the effective dates of the exception. The terms and conditions of the exception appear in the referenced FEDERAL REGISTER notice.

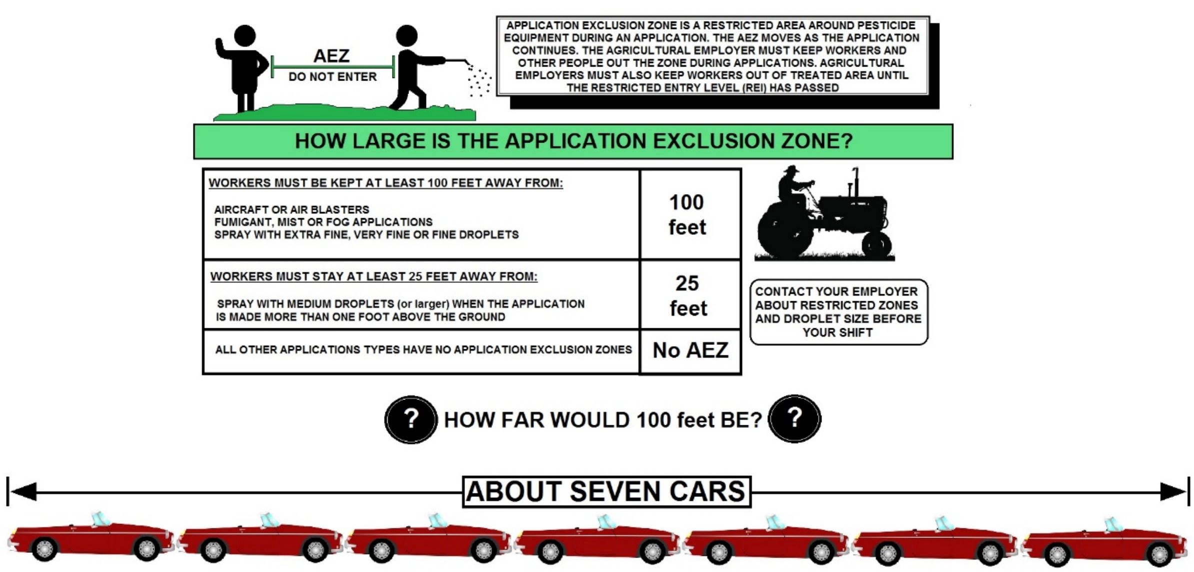
(i) Exception to perform irrigation tasks under specified conditions published in the FEDERAL REGISTER of May 3, 1995.

(ii) Exceptions to perform limited contact tasks under specified conditions published in the FEDERAL REGISTER of May 3, 1995.

[57 FR 38151, Aug. 21, 1992, as amended at 59 FR 30264, June 10, 1994; 60 FR 21954, May 3, 1995; 62 FR 52003, Oct. 3, 1997; 69 FR 53346, Sept. 1, 2004; 71 FR 35546, June 21, 2006; 73 FR 75598, Dec. 12, 2008]



BOOM SPRAYER CALIBRATION



APPLICATION EXCLUSION ZONE (AEZ)

Topic 2- EPA Required Training Citation Section Post Quiz

Information for Agricultural Establishment Operators

1. Commercial pesticide applicators must inform the operator of a farm, forest, nursery, or greenhouse about the following information: The __________and description of the areas on the agricultural establishment that are to be treated with the pesticide(s)

Which Pesticides Uses are Covered?

2. Most pesticide uses involved in the production of agricultural plants on a farm, forest, nursery, or greenhouse are covered by the WPS. This includes pesticides used on plants, and pesticides used on the soil or planting medium the plants are (or will be) grown in. Both general-use and restricted-use pesticides are covered by the_______________ . You will know that the product is covered by the WPS if you see the following statement in the Directions for Use section of the pesticide labeling.

Decontamination Supplies and Requirements

3. ________________ must have adequate water for routine washing, soap and sufficient paper towels. Where there is no running water, early-entry workers and handlers must have at least 10 gallons of water for one employee and 20 gallons of water for two or more employees. The water must be of a “quality and temperature” that will not cause illness or injury.

WPS Requires Providing Decontamination Sites

4. ____________ must establish a decontamination site for all workers and handlers for washing off pesticides and pesticide residues. A decontamination site must be within a quarter (1/4) mile of the employees’ work site.

5. No-contact early-entry workers do not have to be provided the special protections required in Early Entry. However, they must be provided the following protections offered to other agricultural workers: information at a central location, pesticide safety training for workers, notification, restrictions during applications and during restricted-entry intervals, and emergency assistance. Decontamination supplies, however, need **not** be provided to ____________ workers.

Handler Decontamination Supplies

6. Supplies must be provided at the mixing site and within ¼ mile of the application area. Supplies may be in the application area if protected from drift and spray residues. Supplies must include the following: Water—a minimum of ____________gallons per handler or a potable source of tap water

Emergency Information

7. Provide to the worker or handler or to treating medical personnel, promptly upon emergency vehicle, request, any obtainable information on: product name, EPA registration number, and active ingredients for any product(s) to which the person may have been exposed, antidote, first aid, _________________and other medical or emergency information from the product labeling, description of the way the pesticide was being used, circumstances of the worker's or handler's exposure to the pesticide.

Entry Restrictions in the Treated Area

8. Only properly trained pesticide handlers who are wearing the ____________may be in the treated area ("entry restricted area" for greenhouses) while the pesticide is being applied. In most cases, the "entry-restricted area" and the "treated area" are the same thing. For applications to greenhouses, however, the entry-restricted area may be larger than the treated area.

Application Exclusion Zone (AEZ)

9. The AEZ is an exclusion zone that surrounds the application equipment in a 360-degree radius. High drift applications such as air blast sprayers, aerial applications, fumigants, mist and fogging will need a ______________ foot "bubble" where everyone is excluded except for handlers that have the proper PPE and training to work inside that bubble.

10. An "agricultural emergency" means a sudden occurrence or set of circumstances which the agricultural employer could not have anticipated and over which the agricultural employer has no control, and which requires entry into a treated area during a restricted-entry interval, when ____________would prevent or mitigate a substantial economic loss.

Topic 2- EPA Required Training Citation Section

1. Specific location, 2. WPS, 3. Workers, handlers and early-entry workers, 4. Employer(s)
5. No-contact early-entry, 6. 3, 7. Statement of practical treatment, 8. Required PPE, 9. 100
10. No alternative practices

Topic 3- Bee-Like Insects Section

Section Focus: You will learn the basics of honeybee–like insects. At the end of this section, you will be able to understand and describe different Halictid (Halictidae) insects. You will learn about the Halictid bee family class, genera, life cycle and related subjects. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Halictid (Halictidae) is the second-largest family of Anthophila bees. Halictid species occur all over the world and are usually dark-colored and often metallic in appearance. Several species are all or partly green and a few are red; a number of them have yellow markings, especially the males, which commonly have yellow faces, a pattern widespread among the various families of bees. The family is distinguished by the arcuate basal vein found on the wing. It is critical that pesticide applicators master control of this pest target in that we do not destroy other wildlife during treatment operations.

Halictid Bees - Family Halictidae

Order Hymenoptera / Suborder Apocrita -- abeilles, ants, bees, fourmis, guêpes véritables, narrow-waisted hymenopterans, true wasps. Infraorder Aculeata / Superfamily Apoidea -- bees / Family Halictidae -- halictid bees, sweat bees.

Identifying Characteristics for the Family Halictidae include:
As in other families of the superfamily Apoidea, members of the family Halictidae have:

- ✓ a collar-like pronotum without projections that reach the tegulae,
- ✓ body hairs that are branched or plumose, and
- ✓ First segment of the metatarsus often enlarged and flattened.
- ✓ 1 sub-antennal suture (andrenid bees have 2).
- ✓ Front wing with basal vein strongly arched.
- ✓ Hind wing with jugal lobe longer than the sub-median cell.
- ✓ Thorax of some species metallic green like the chrysidid wasps, but halictids lack the sculptured cuticle and the ability to curl.

In many species, the tongue is long and pointed, adapted for probing into flowers. All bees are covered with hair, to which pollen sticks when flowers are visited; most female bees have apparatus for gathering this pollen; it is combed into a special basket or brush located on the hind legs. Males do not collect pollen and lack these structures. There are a few species, especially the parasitic bees that have no pollen baskets

Bees that live Underground
What bees live in the ground, and what bees live? There are many species of ground-nesting or miner bee in North America alone, forming an interesting subject for the entomologist, behavioral biologist, or gardener. The spring time will herald the return of these species, which play an active role in pollinating flowers by extracting pollen and nectar. These bees are generally solitary, their queens living in underground galleries with their young. It is not uncommon for queens to form nests nearby to other queens, but more on this later.

In terms of what bees live in the ground, as we have mentioned, there are several genera common in the United States. Of these, Colletes, Lasioglossum, Halictus, Agapostemon, and Andrena are significant, with Colletes inequalisin particular being abundant in the Northeastern and Midwestern regions of the United States.

The species within these genera form recognizable nests, piles of dirt with holes in the center about one-quarter of an inch wide, though it is important to distinguish these nests from yellow jacket nests. These latter insects are very different from the solitary bees, which are regarded as harmless. Though many gardeners may see bees and wasps as pests, the solitary bees are unlikely to sting unless greatly provoked, and entomologists recommend avoiding pesticide use with these creatures.

Some significant families of ground-nesting bees are listed below (these families include several of the genera already mentioned above):

- Andrenidae (miner bees)
- Anthoporidae (digger bees)
- Halictidae (sweat bees)

Many of the bees that live in the ground fall under the solitary bee category, though not all of them do. Bumblebees, in the genus Bombus, also form nests in the ground, though they are not solitary, living as they do in colonies that can reach several hundred members. Though they are not quite flying solo, bumble bees are more solitary than their more famous relatives, the honey bees, which utilize signaling mechanisms to alert workers to the best flowers to pollinate.

Though the bumblebee is not a solitary bee, it has some behaviors in common with the solitary bee species, pollinating flowers diligently and alone. Bumblebees are also regarded as less aggressive than the more social bees that live in huge, complex colonies. Perhaps the best way to examine the solitary bees and their habits is to hone in on one species to study. Colletes inaequalis, a solitary ground-nesting bee that closely resembles Apis mellifera is a good choice for study.

You may have queens of this species in your backyard without knowing it. Like other solitary bees, Colletes inaequalis queens build galleries in the ground where they birth their brood, and it is common for as many as thousands of these queens to build nests in close proximity to each other. Most ground-nesting bees have a strong preference for dry, sandy soils, so an easy way to prevent them from nesting is to water the soil regularly with a sprinkler, but as the bees are benign, this may not be necessary.

Although Colletes inaequalis queens burrow nests and rear their young alone, a common activity in the springtime is for males to look for queens to mate with. In spite of this increased activity in your backyard or garden, the males do not have a sting. As with other ground-nesting bees, the Colletes inaequalis queens form recognizable mounds, so it should be easy to tell if they are present in your backyard.

Other Bees in Alphabetical Order

Carpenter Bee

Carpenter Bees
Male carpenter bees are solid black, they also cannot sting. The females are tan in color and sting quite well. Carpenter bees are sometimes mistaken for bumblebees, however carpenter bees are shiny with less hair. Their flight is faster than a bumblebee's, and is also a more jerky flight, very similar to a hummingbird.

Carpenter bees are solitary bees burrowing holes the size of a dime or penny into wood patio covers, eaves, and other places. Average size is one inch in length.

Mining Bees
Several of the more distinctive mining bees are from the large family Andreninae. These fascinating little bees are sexually dimorphic and many species are quite difficult to identify. Often the smaller honeybees are mining bees. They are not to be confused with 'Digger Bees', although most species of both types of bees make their nests underground.

They actually belong to different families of bees: Andrena belonging to the family 'Andrenidae' whilst digger bees (actually the genus 'Anthophorini') are part of the 'Apidae' family, along with bumblebees and honeybees.

Bumble Bee or Carpenter Bee?

When encountering black, almost round bees buzzing around their home most people do not know the difference between the bumble bee and carpenter bee. There are two basic things to note that should quickly let you know which bee you are seeing: location and activity of the bee and certain physical characteristics of the bee.

BUMBLE BEE

CARPENTER BEE

Carpenter bees are most often noticed while they are building and tending to their nests which are simple, round openings in wood structures. If you see a bee that is boring out a perfectly round hole in wood, it is a carpenter bee. Bumble bees have a fuzzy abdomen and the Carpenter Bee has a shiny abdomen.

General Bumble Bee Information

The "Bumble Bee" is a big, hairy, black and yellow bee whose size can range from 3/4 inch to 1 1/2 inch. This insect is often mistaken for a carpenter bee, which closely resembles the bumble bee in appearance. Carpenter bees have a shiny and smooth abdomen as opposed to the fuzzy abdomen seen on a bumblebee. There are over 200 types of Bumble bees in the world. Fifty different types can be found in North America. Each different species will have its own preference to types of nectar and prefers different flowers.

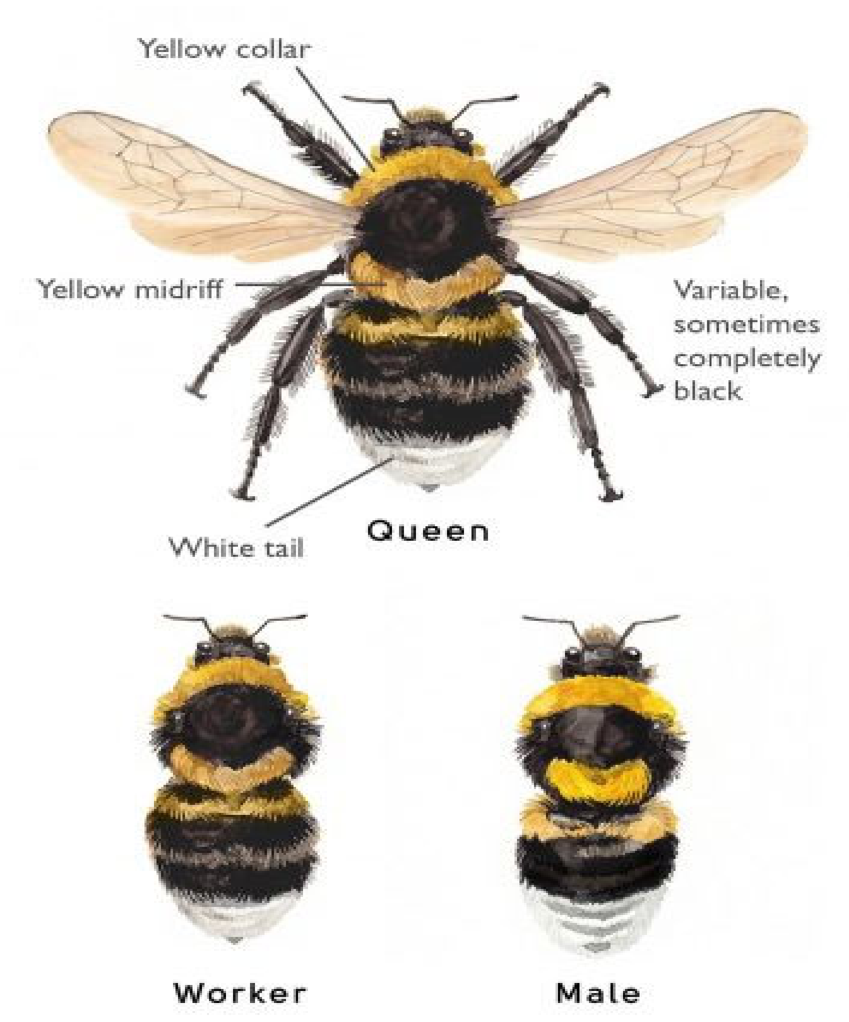
The bumblebee is an important, beneficial insect. They pollinate plants and flowers as they forage for food. To gardeners, it is a welcome sight to see these large, flying insects carrying large loads of pollen, flying into and around their flower beds and gardens. While busy searching for food (and at the same time, pollinating plants) bumble bees are rarely a problem when in close proximity to humans. They will actually (in most cases) go out of their way to avoid human contact. Bumble bees will, however, defend themselves if they sense that they are cornered and cannot escape. Most of the time they will fly away from danger but will sting if they are under duress.

Bumblebees have very few predators in nature. Skunks are their largest and most destructive predator. Skunks are omnivores that will eat insects, rodents, reptiles, small mammals, worms, eggs, fish, fruit, and plants. When they locate a bumble bee nest, skunks help themselves to bee larvae and adult insects. They ignore the pain of bee stings to get to their preferred foods.

Queen Bumblebee

The queen bumblebee comes out of hibernation every spring to find a new spot to build her nest and start a new colony. The queen bee is fertilized the previous season and has managed to live through the winter months. The same nesting spots (from previous seasons) are rarely used. A suitable place for nesting is usually on the ground, beneath a flat object. An old mouse hole or similar hole in the ground is preferred if it is underneath an old tarp, flat stone or man-made objects such as a deck. The hole chosen by the queen bee is first padded by pieces of vegetation such as dry grass or moss.

It is in this padded underground hole that the fertilized queen bumblebee lays her eggs and begins collecting nectar for her soon to hatch grubs.



Once the grubs emerge from their eggs, the queen bumblebee spins a protective silk cocoon for each grub. It is from this first batch of larvae that 5 to 20 daughters emerge. These daughters of the queen bumble bee are workers who immediately start working on building the colony.

The queen bee will continue to lay eggs for the remainder of the summer season. The workers work tirelessly to build the colony, collect nectar for the young and also to provide protection for the colony. The first batch (or hatching) of bumble bee workers are smaller than their sisters who will emerge later on when the colony grows larger and healthier.

The queen bee uses her energy to begin the nest and this energy (as well as time) is spread thin as she is the sole worker for the new colony. As the colony grows, the eggs and larvae are given more attention and food simply because there are many workers that share the work load. It is at this point in time that larger bumble bees are seen.

Bumble bees are often first noticed (in the area of the nest) when this activity of guarding the nest and pollen collecting begins. The worker bees are focused only on their job and will not go out of their way to sting people. It is only if people get too close to their nest or threaten them that bumble bees will sting. Bumble bees do not die after stinging, as do some other stinging insects.

Towards late summer, the queen will start to produce drones and young queens. The young queens are fertilized by the drones, and then fly off to hibernate. Hibernation usually takes place in dry protected areas such as loose bark. The colony's remaining drones and workers stay in the colony and die during the winter season. The young queens start new colonies in the spring of the year. As mentioned above, bumble bees do not use the same nest, though they may nest in an area close by the original bee nest.

Bumblebee Control

Bumblebees are very important, beneficial insects that pollinate plants and flowers. Their activity in gardens is desirable, but allowing them to nest in areas where children and pets frequent or where you garden is not desirable.

When adults, children or pets frequent an area where bumble bees have made their nests, the beneficial bumble bee can become a pest. A disturbed nest is an unhappy and angry nest! Although skunks can tolerate a bee's sting (or multiple stings) while collecting food, other animals cannot tolerate the sting. Dogs are often on the receiving end of angry bee stings. A dog's curiosity can get it into trouble with stinging insects. While investigating the activity of a nest, dogs usually get stung on their face; most of the time their snout and nose are easy targets for the bees. When the dog investigates the sounds and activities of a bumble bee nest they are usually attacked on facial areas, resulting in painful stings accompanied by large swelling at the site of the sting. The size of the swelling can be alarming, simply because there is very little muscle or fat on most dogs' face and muzzle area. To prevent bees from becoming a stinging pest, take action to remove possible nesting sites that would put a new colony in close proximity with children and adults that frequent certain parts of the property.

The most important element of wasp and bee control is to *destroy the nest*. Aerosol "wasp and hornet" sprays can be used to knock down bees/wasps around the nest. Small amounts of pesticides (dust and wettable powder formulations work well) applied into the nests of carpenter bees and cicada killers provide good control. Nests of mud daubers also can be treated this way or by simply scraping them off structures. To prevent re-infestation, finishes (paint, etc.) can be applied to unfinished wood to discourage carpenter bees.

In some cases, attempting to destroy a nest becomes a greater health risk than simply tolerating and avoiding it. But nests, especially those of social species, should be destroyed if they are close enough to humans to pose a stinging threat. The nests of honeybees, bumble bees, yellowjackets and hornets should always be approached with caution, preferably at night when most of the workers are present but reluctant to fly. Try not to *carry* a light, as wasps and bees may fly toward it. Instead, set the light aside or cover it with red cellophane (insects cannot see red light). If there is direct access to the nest, a fast-acting dust or wettable powder formulation can be applied.

If possible, inject the material into the nest. If you must approach these nests during daytime, a quick knockdown aerosol can be used to keep the bees/wasps at bay, while you treat the nest as above. Heavy clothing or a “bee suit” can be worn for added protection.

Sometimes, yellowjacket and honeybees nests occur in voids such as vents, attics, crawlspaces or hollow walls. Destroying nests in these locations can be difficult, often requiring the services of pest management professionals. Honeybee nests contain honey that must be removed after the bees are eliminated because it will rot and attract secondary pests. Also, be mindful that nests may be located several feet away from the point at which the bees/wasps are entering the structure. Simply applying pesticides into the entrance holes may not be sufficient. It may be necessary to drill into the structure to enable injection of pesticides directly into the nest.

Entrance holes should never be plugged, even after treatment, because the bees/wasps will look for other ways to get out of the nest and have been known to chew their way into living quarters, endangering persons inside. Also, use extreme caution when performing bee/wasp control from a ladder.

Another special case occurs when large numbers of yellowjackets forage in public areas such as parks, schools and zoos. Attracted to human food, especially meats and sweet liquids, wherever it is being prepared, eaten or discarded, yellowjackets pose an increased threat to humans. Control is often difficult.

When located in wooded areas, the nests can be difficult if not impossible to find and treat. Yellowjacket baits and traps can kill large numbers, but there can be a lot more where they came from and the problem may continue. Other types of pesticide applications for control of yellowjackets in outdoor recreation areas are rarely effective. Consequently, management of yellowjackets should focus on prevention, such as keeping food enclosed. Tight-fitting lids should be kept on outdoor trash containers and they should be moved away from people. In the end, not eating in infested outdoor areas may be the only sure way to avoid being stung.

NOTE: When pesticides are used, it is the applicator’s legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

Cellophane Bee

Bees of the genus *Colletes* line the cells of their nests with a waterproof material which, when dry, resembles clear plastic. Accordingly, they are sometimes called “cellophane bees” or, alternately, “polyester bees”. Cellophane bees are equipped with unusual forked tongues, which they use to paint the plastic-like material onto their nest walls in order to keep their nests dry. The bees produce the material from a special abdominal organ called the Dufour’s gland, named after French naturalist Léon Jean Marie Dufour, who first recorded his fascination with the bees’ fabrication of *plastique* in 1835.

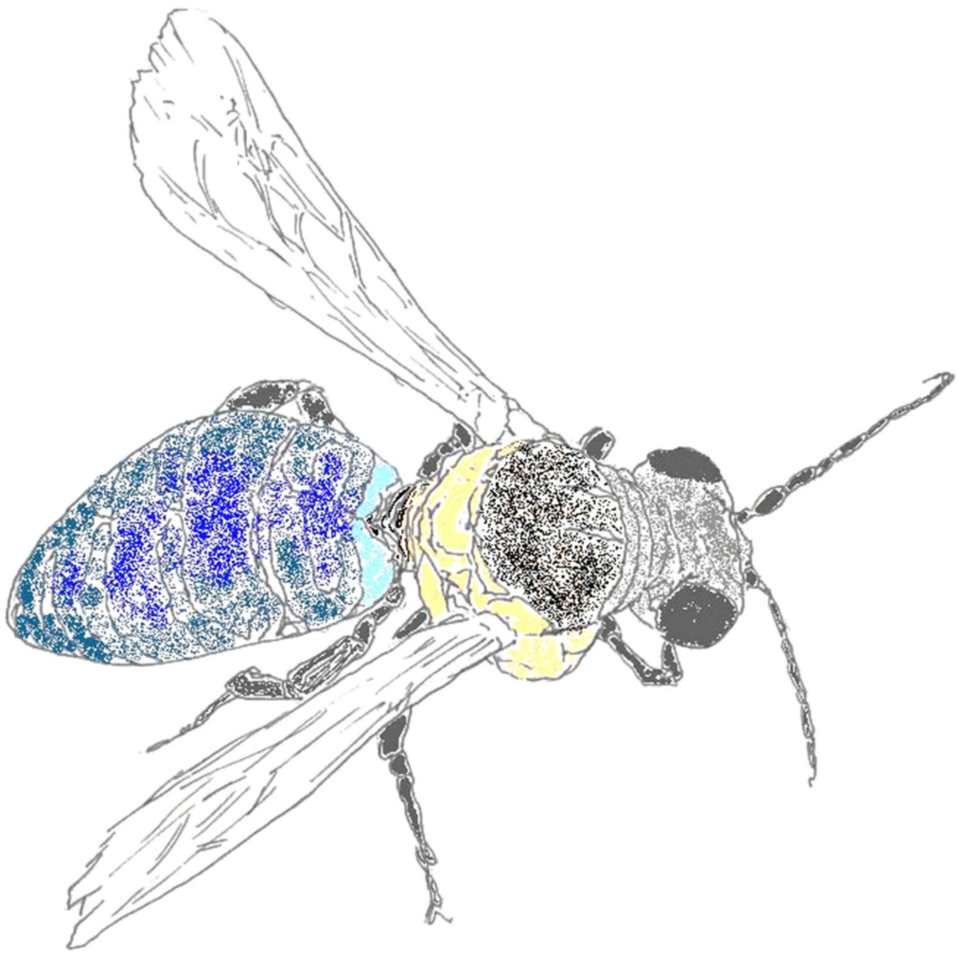
According to the Xerces Society's *Guide to Attracting Native Pollinators*, cellophane bees also spray their egg-cell walls with a natural fungicide and bacteriacide, linalool, secreted from a gland in the bees' mandibles. After coating their cells, the bees fasten their eggs onto the cell walls rather than leaving them on nest floors where moisture might collect. The bees provision their cells by mixing pollen and nectar together to make a liquid “bee bread” for their offspring; these provisions are stored in cellophane sacs that look a little like elongated plastic sandwich bags. The special measures taken by the bees to protect their eggs against water and fungus allow them to build nests near stream banks and other areas with wet soils.

Cellophane bees are solitary. They construct individual nests in the ground, excavating tunnels that exit through small round holes. Despite their solitary status, the bees tend to build their nests near one another. Groups of nesting cellophane bees sometimes number into the tens of thousands. These bees, however, are non-aggressive and do not form swarms. They are important pollinators of spring trees, crops and wildflowers.

The tomatillo is a plant originating in Mexico and bearing green tomato-like fruits encased in papery husks. Cultivated by the ancient Aztecs as long ago as the 14th Century, the tomatillo has made its way into the United States and into our gardens and cuisine. At the heart of this plant's long history is the beautiful broad-footed cellophane bee, a pollinator that specializes in the flowers of tomatillos (*Physalis philadelphica)* and other native plants of the genus *Physaylis.*

These bees are occasionally seen as well on Chinese lantern (*Physalis alkekengi*), a plant that grows in Stone Barns’ cut-flower fields during the same period. Chinese lantern, although Asian in origin, is a relative of the Mexican tomatillo.

Cuckoo Bee



Cuckoo Bee

Cuckoo Bees are parasites, in that the female cuckoo bee lays her eggs in the nest of other bees, primarily digger bees and Andrenids. Cuckoos are also said to be kleptoparasites, stealing honey and pollen collected by others. Cuckoo bees lack any pollen-transporting apparatus (the scopa). Look for cuckoo bees flying low over the ground and foliage, hunting for foraging and nesting potential victims.

There is also a family of cuckoo wasps which lay their eggs in the nests of potter and mud dauber wasps; many types of wasps in various families have evolved similar habits. These insects are normally referred to as "kleptoparasites," rather than "brood parasites." The distinction is that the term "brood parasite" is generally restricted to cases where the immature parasite is fed directly by the adult of the host, and raised as the host's offspring (as is common in cuckoo birds). Such cases are virtually unknown in bees and wasps, which tend to provide all of the food for the larva before the egg is laid; in only a few exceptional cases (such as parasitic bumblebees) will a bee or wasp female actively feed a larva that is not her own species.

The difference is only in the nature of the interaction by which the transfer of resources occurs (tricking a host into handing over food rather than stealing it by force or stealth), which is why brood parasitism is considered a special form of kleptoparasitism.

The term **cuckoo bee** is used for a variety of different bee lineages which have evolved the kleptoparasitic habit of laying their eggs in the nests of other bees, reminiscent of the behavior of cuckoo birds. The name is technically best applied to the apid subfamily Nomadinae. Females of cuckoo bees can be easily recognized in almost all cases, as they lack pollen collecting structures (the scopa) and do not construct their own nests.

They often have reduced body hair, abnormally thick and/or heavily sculptured exoskeleton, and saber-like mandibles, though this is not universally true, and other less visible changes are common, as well. They typically enter the nests of pollen-collecting species, and lay their eggs in cells provisioned by the host bee. When the cuckoo bee larva hatches it consumes the host larva's pollen ball, and, if the female cleptoparasite has not already done so, kills and eats the host larva.

In a few cases where the hosts are social species (e.g., the subgenus *Psithyrus* of the genus *Bombus*, which are parasitic bumble bees that infiltrate nests of non-parasitic species of *Bombus*), the cleptoparasite remains in the host nest and lays many eggs, sometimes even killing the host queen and replacing her - such species are often called **social parasites**, though a few of them are also what are referred to as "brood parasites."

Many cuckoo bees are closely related to their hosts, and may bear similarities in appearance reflecting this relationship. This common pattern gave rise to the ecological principle known as "Emery's Rule". Others parasitize bees in different families, like *Townsendiella*, a nomadine apid, one species of which is a cleptoparasite of the melittid genus *Hesperapis*, while the other species in the same genus attack halictid bees.

The number of times cleptoparasitic behavior has independently evolved within the bees is remarkable; C. D. Michener (2000) lists 16 lineages in which parasitism of social species has evolved (mostly in the family Apidae), and 31 lineages parasitizing solitary hosts (mostly in Apidae, Megachilidae, and Halictidae), collectively representing several thousand species, and therefore a very large proportion of overall bee diversity. There are no cuckoo bees in the families' Andrenidae, Melittidae, or Stenotritidae, and possibly the Colletidae (there are only unconfirmed suspicions that one group of Hawaiian hylaeine species may be parasitic).

Green Bee

Green Bee, Family Halictidae

The orchid bees are all members of the family Apidae, and the tribe Euglossini, represented by five genera. Most are about the size of a honey bee, but are brightly colored with an iridescent metallic sheen. Typically, each species of orchid bee has a complex mutualistic relationship with a corresponding orchid in their native range. Orchids will produce scents that attract males of a particular species of bee that is the right size and shape to pollinate them. This relationship is not always chemical; some species of orchid go so far as to produce flowers that physically mimic a female bee as an attractant.

Orchids will then affix a pollinarium to the bee which is carried to another orchid of the same species. All orchid bees are native to the New World tropics, from Mexico throughout Central and tropical South America.

Specimens of one species of this group, *Euglossa dilemma*, commonly known as the green orchid bee, were collected in Broward County, Florida in 2003 by entomologists working with the USDA fruit fly monitoring program. This arrival was likely from a nest imported from Mexico concealed within a wooden structure such as a pallet. Originally considered to be *Euglossa viridissima*; Eltz et al. (2011) found the orchid bees in Florida to be *Euglossa dilemma*, a newly described cryptic sibling species of *Euglossa viridissima*.

MASON BEE

MASON BEE

This example of a mason bee is approximately a quarter size of a normal honeybee. There are several species and several color variations. This mason bee looks very similar to a honeybee. Some people call these creatures, “Tiny honeybees”.

Most bees are solitary -- each female constructing a nesting tunnel underground or in plant materials. She stocks the brood cells with pollen and nectar for the larvae to eat after hatching.

Honeybees and bumblebees, however, are social insects -- They live in colonies consisting of a fertile queen, sterile female worker bees, and male bees (drones). These are the only bees known to produce honey, and they are the only bees which will sting readily in defense of their colonies.

MASON BEE

Mason Bee
Smaller than a honeybee, mason bees resemble house flies more than honeybees. They are deep blue-black in color and have no stripes. Mason bees are native to North America. They are active pollinators between cherry blossom and apple blossom season, and then die out by summer. Attract mason bees by providing them a home. Drill holes exactly 5/16-inch in diameter into wooden blocks and mount the blocks by cherry blossom season facing morning sun.

Species of the genus include the orchard mason bee, Osmia lignaria, the blueberry bee, O. ribifloris, and the hornfaced bee, O. cornifrons. The former two are native to the Americas and the latter to Japan, although O. lignaria and O. cornifrons have been moved from their native ranges for commercial purposes. The Red mason bee, Osmia rufa, is found across the European continent.

There are over 300 species across the Northern Hemisphere, and more than 130 species of mason bees in North America; most occur in the temperate regions, and are active from spring through late summer.

Osmia species are usually metallic green or blue, though many are blackish. Most have black ventral scopae which are difficult to notice unless laden with pollen. They have arolia between their claws unlike Megachile or Anthidium species.

Mining Bee

MINING BEE

Miner bees, also known as chimney bees, are smaller than a honey bee, with a stout, furry body. They are often mistaken for bumble bees, also being black and yellow summertime bees. They are friendly, non-aggressive and typically do not sting or bite. Despite their small stature, mining bees are very important to flower pollination, especially in the mid-west region of the United States. *Anthophora abrupta's* geographic distribution ranges from Texas to Florida, stretching up the East Coast to Canada.

Miner bees are most well-known and studied due to their complex nesting behavior. Miner bees are solitary, ground nesting bees that like to establish their home in well-drained soils, like clay, present in banks, hills, and road cut-outs. They have also been found burrowing between stones of old buildings and between logs in cabins or barns. Most commonly, female bees dig a tunnel in the soil using loose earth to construct a chimney-like turret, which represents a single nest. Nests are often clustered together in close quarters but females only provide for their own nest and future offspring with no overlap in generation. Miner bees have been known to nest in the same location for many years.

After mating and establishing their nests, *A. abrupta* females line the tunnel walls with a glandular secretion which turns to a solid waxy plate. This process waterproofs a cup-like cell for the provisioning of the eggs. A single egg is laid in each cell and floats on a pollen mixture foraged by the females for about five days before hatching. The larvae proceed to consume the pollen substance and cell lining over the following three weeks. The offspring overwinter in the prepupae stage, and come April, they shed their skin and two weeks later emerge from their burrows as adults.

The head, legs and abdomen of *A. abrupta* are lightly coated in brown-black hairs while the thorax is covered in dense, pale yellow-orange hairs. The wings are nearly transparent to slightly cloudy with brown-black veins.

Key points

- Mining, ground, or digger bees nest in burrows in the ground.
- Mining bees are solitary bees. Each mining bee female usually digs her own burrow to rear her young.
- Large numbers of these bees may nest close together if soil conditions are suitable and will fly just above the ground. When this happens they frequently become a nuisance to some people.
- They are not aggressive, seldom sting, and their flying activity lasts only 2 to 4 weeks.
- Sometimes large numbers of males will fly about the same spot for several days in a mating display.
- Bee populations can fluctuate dramatically from one season to the next.

General Information

- Mining bees range in size from about the size of honey bees (largest), down to much smaller species.
- The larger bees are furry and usually darker in color than honey bees. Some are brightly striped, while others are shiny metallic green.
- Mining bee burrows tend to be located wherever there is exposed soil, thin grass, and good drainage. The holes are about 1/4 inch in diameter and are sometimes surrounded by a small mound of soil.
- Burrow structure varies according to species but often there is a vertical tunnel with smaller side tunnels that terminate in a single cell.
- The female mining bee stocks each cell with pollen and nectar she collects from flowers and then deposits an egg on the food mass.
- As eggs hatch and larvae develop they consume the stored pollen and nectar. When mature, each larva becomes a pupa (resting stage) and then becomes an adult bee.
- The adult bees overwinter below ground in the burrow site. During the next spring or early summer, the adults emerge, mate, and the females begin burrow excavation.

Management

- Mining bees are important pollinators and control should be avoided if possible.
- Heavy watering with a lawn sprinkler will discourage nesting behavior.
- Long-term control involves the elimination of bare-ground areas and the establishment of dense turf to discourage these bees.
- If the area is not conducive to a healthy lawn, groundcovers or heavy mulches may provide an alternative solution.

Orchard Bee Not to be confused with Orchid Bee *See Mason Bee*

Osmia lignaria, commonly known as the **orchard mason bee** or **blue orchard bee**, is a megachilid bee that makes nests in reeds and natural holes, creating individual cells for their brood that are separated by mud dividers.

They are unlike carpenter bees in that they cannot drill holes in wood. *O. lignaria* is a common species used for early spring fruit bloom in Japan, Canada, and the United States, though a number of species of other *Osmia* are cultured for use in pollination. Orchard mason bees, like all mason bees, are very shy and will only sting if the bee believes it is in serious danger. It will not attack to defend itself. The stinger itself is actually an egg guide.

Orchid Bee *Not to be confused with Orchard Bee*

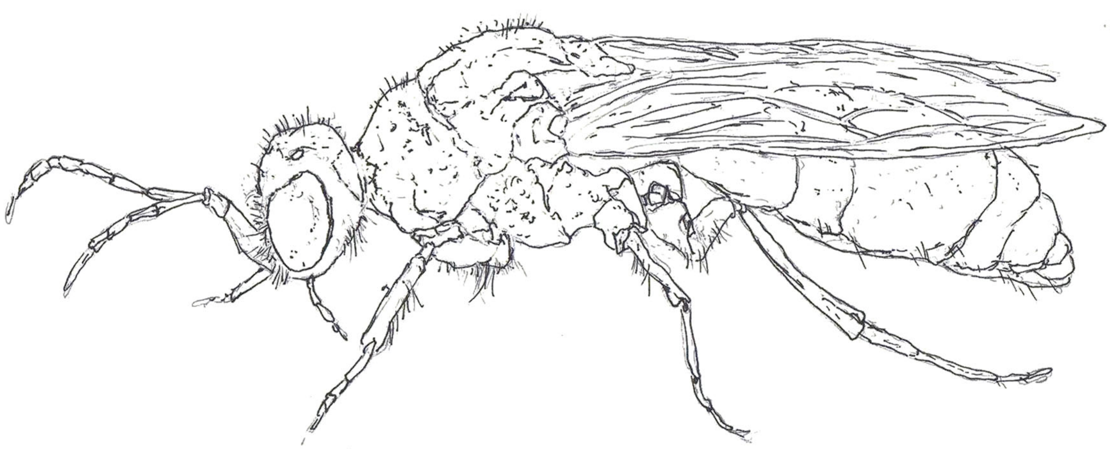
Male orchid bees have uniquely modified legs which are used to collect and store different volatile compounds (often esters) throughout their lives, primarily from orchids in the sub-tribes Stanhopeinae and Catasetinae, where all species are exclusively pollinated by euglossine males. These orchids do not produce nectar, and hide the pollen on a single anther under an anther cap; they are not visited by females. The whole pollinarium becomes attached to the male as it leaves the flower. Several flowers from other plant families are also visited by the bees: *Spathiphyllum* and *Anthurium* (Araceae), *Drymonia* and *Gloxinia* (Gesneriaceae), *Cyphomandra* (Solanaceae), and *Dalechampia* (Euphorbiaceae) contain one or more species that attract male euglossines.

The chemicals are picked up using special brushes on the forelegs, transferred from there by rubbing the brushes against combs on the middle legs, and finally these combs are pressed into grooves on the dorsal edge of the hind legs, squeezing the chemicals past the waxy hairs which block the opening of the groove, and into a sponge-like cavity inside the hind tibia.

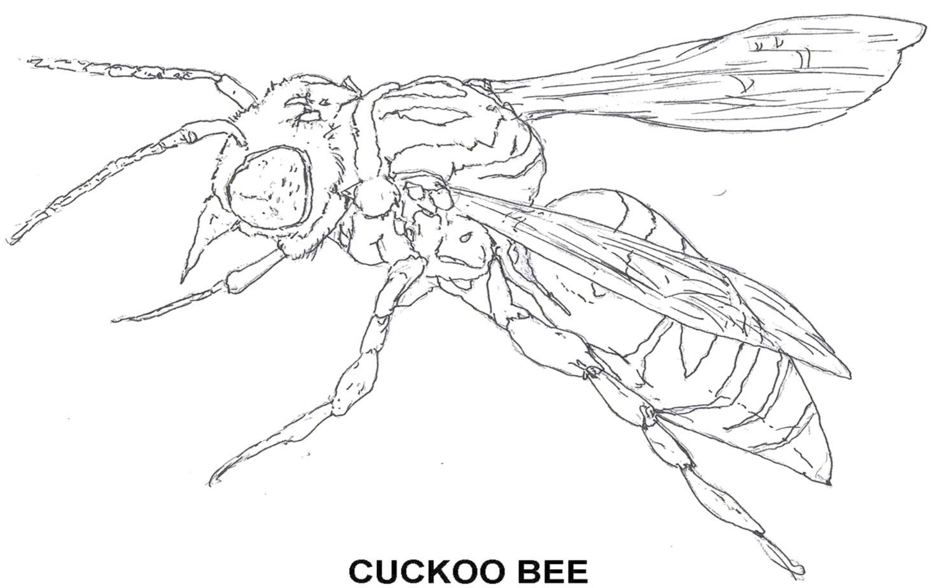
The accumulated "fragrances" are evidently released by the males at their display sites in the forest understory, where matings are known to take place. Although the accumulated volatiles have long been believed to serve as a signal to females, female attraction to male odors has never been demonstrated in behavioral experiments. The behavior of volatile collection is essentially unique in the animal kingdom. Single synthetic compounds are commonly used as bait to attract and collect males for study, and include many familiar flavorings and odors considered appealing to humans (e.g., methyl salicylate, eugenol, cineole, benzyl acetate, methyl benzoate, methyl cinnamate), and others which are not (e.g., skatole).

Neotropical orchids themselves often exhibit elaborate adaptations involving highly specific placement of pollen packets (pollinia) on the bodies of the male orchid bees; the specificity of their placement ensures that cross-pollination only occurs between orchids of the same species.

Different orchid bee males are attracted to different chemicals, so there is also some specificity regarding which orchid bees visit which types of orchid. Not all orchids utilize euglossines as pollen vectors, of course; among the other types of insects exploited are other types of bees, wasps, flies, ants, and moths. The male *Eufriesea purpurata* is highly unusual in actively collecting the insecticide DDT in huge amounts from houses in Brazil, without suffering any harm from it.



BLUE ORCHID BEE



CUCKOO BEE

Plasterer Bee

Colletes inaequalis

Not all bees live in hives like honey bees do. In fact, 70% of all the 20,000 species of bees nest under ground. In North America, most of these ground bees become active in early spring. Nests of these bees are easy to identify above ground because of the conical piles of dirt with a large hole in the middle that serves as the entrance to the bee burrows.

One of the most abundant ground nesting bees in northeastern and midwestern region of North America is *Colletes inaequalis*. Even though this bee is solitary, meaning that every individual female builds her own nest, it is also a gregarious nester. Many females (hundreds and sometime thousands) build their nests next to each other. The nests are obvious above ground because of the conical piles of dirt with a hole in the middle.

Colletes inaequalis has a strong preference for sandy soils on south facing slopes. Thus, if you have these conditions in your backyard, you may find these bees showing up every year where you live. Unlike social bees and wasps, solitary species are not aggressive insects even though females do have sting. These bees will not attempt to sting humans unless handled. Most activity at nest sites in early spring is of males looking for females to mate with – male bees cannot sting. Besides *C. Inaequalis,* many other ground nesting native bees can be found in your backyard.

Species of the bee genera *Agapostemon*, *Andrena, Halictus,* and *Lasioglossum* are also very abundant in North America. All of these native bee species provide important ecological services that include pollinating many of the plants in your garden and nearby. Specifically, *Colletes inaequalis* and similar looking *Andrena* species are important pollinators of spring crops like apples, blueberries and cherries. Therefore, we do not consider these bees as pests and strongly recommend avoiding the use of chemicals to control them.

Pesticides are bad for humans and beneficial insects. Usually, using water over the area of the nest is enough to encourage the bees to look for a different nesting area. However, due to their beneficial role as pollinators and their lack of aggressive behavior, please consider maintaining these important bee pollinators in your backyard!

Sweat Bee

Agapostemon splendens

Sweat bee is the common name for any bees that are attracted to the salt in human perspiration. Sweat bees, which are important native pollinators in the Northern Hemisphere, where there are about 1,000 species.

Mostly seen hovering bushes and flowers. In its strict application, the name refers to members of the Halictidae, a large family of bees that are common in most of the world except Australia and Southeast Asia, where they are only a minor faunistic element. In the USA, the common species are black, brown, red, or metallic green, and sometimes with yellow markings, and usually 1/4 to 1/2 inch (4-10 mm) in size. Their attraction to sweat makes them a nuisance, as they will sting if squeezed or squashed against one's flesh.

As with many common names, however, the term "sweat bee" is applied colloquially to different insects in different continents, despite its technical restriction to halictids. Thus, in Africa and parts of Southeast Asia, the colloquial name is used to refer to what are technically known as Stingless Bees, which are typically in the genus Trigona and its relatives (family Apidae), and also have the habit of taking up salt from human perspiration. The Western honeybee, Apis mellifera also occasionally laps human perspiration, as will other bees upon occasion.

Behavior of Sweat bees
Honey bees are known to produce honey and build their nests in attics and wall voids. The Sweat bees don’t do any of that. Sweat bees make their nests on the ground mostly, while some of them build their homes in rotten wood. You can spot such nests inside hollow trunks, or underground too.

While most Sweat bees live in solidarity in underground nests, there are also some of them that live together by building nests in groups. Sweat bees make nests that can hold only one queen bee at a time, but sometimes they have more than one queen bee who stay in the same hive, but in separate cells.

What do Sweat bees eat?
Sweat bees though are lured by the salt found in human sweat, they actually eat nectar and pollen found in flowers, and also qualify to be significant pollinators among the plant species. They also gather pollen in large quantity and store them for their baby bees.

The larvae that develops in the nests that are built underground, eat from the pollen and nectar that the bees had provided after they laid eggs there. Just like the athletes drink beverages containing electrolytes to boost their energy and to supplement their diet with salts, even bees do the same by trying to obtain salt from human sweat.

Do the Sweat bees Sting or Bite?
Their sting is only rated a 1.0 on the Schmidt Sting Pain Index, which is relatively harmless. However, individuals with allergies to any kind of insect should seek immediate medical attention. Pest control is not recommended due to their beneficial nature in pollination. Also, you'd be surprised to know, the male bees never sting. It is only the female bees that are known to mildly sting you when you try to swat them away, or when they feel aggravated. The Sweat bees deliver only mild stings that are painless, but they mostly swarm in hundreds to attack, which can be dangerous.

How to treat Sweat Bee Sting?
Though the sting is mild, the stinger may continue injecting venom for a long, long time. Therefore, it becomes necessary to remove the stinger from where the bee has bitten you. Try and scrape the stinger out of your skin by using a nail file or the edge of your debit/credit cards and gently push it out of your skin. Remember not to pinch the sting with your hand because it will accelerate the release of venom even further. Also, you should wash the affected area with water and soap and follow it up by using a cold compress to reduce the swelling. If you experience irritation in the affected area, a hydrocortisone cream applied topically can help to soothe the area. Alternatively, you could apply a paste of baking soda and water to heal the area.

Are Sweat bees advantageous or harmful to the environment?
Not just sweat bees, but all types of bees are vital to our ecosystem. They help in sustaining a variety of plant species by carrying out pollination amidst vegetation that expands to large distances. In this way, they keep the vegetation lively. There are many who strive to keep the bees alive and help them breed because the bees accelerate the growth of their crops and garden vegetation indirectly.

Did you know, the population of bees has dropped dramatically recently? You should not try to harm the bees unnecessarily as that can threaten their population further. The 'Colony Collapse Disorder' has affected some of the bee species in a gruesome manner due to increasing pollution and rising toxins found in the soil.

FYI, Colony Collapse Disorder or CCD is a situation when the queen is left behind in the colony alone, with abundant food and a few nurse bees to cater for the remaining immature bees and the worker bees all disappear in majority. Sweat bees only help our environment and do not damage it under any case. You should also strive to protect the bees.

What is their human and ecosystem connection like?
Why they have earned that infamous name of being termed as 'sweat bees' is because of the bees' tendency to sit on humans with the intention to lick their salty sweat, and also get moisture from the perspiration. Though you can easily shoo them away with a gentle scrape,

if it’s a female bee, it may attack you with a mild sting in defense. Don’t worry, as we said, they’re painless.

Kleptoparasitism
One strange behavior of sweat bees is that they qualify to be stealers. Yes, some sweat bees fall under the category of insects that show the behavior of ‘kleptoparasitism’ where klepto means stealing. There are some sweat bees that sneak into other bees’ species’ nests, eat the owners’ eggs, and replace them with their own laid eggs after having the food provided for the eggs. Kleptoparasites tend to depend on their hosts for all their life.

How can you get rid of the Sweat Bees?
Because sweat bees are attracted to humans due to their sweat, it is ideal to take some preventive measures. You could use a DIY spray as a repellent to knock off the bees. All you need to do is fill one-fourth of the bottle with dish soap and the remaining with water and target on the bees to keep them away. You could also rub peppermint oil or tea tree oil on your skin as the smell helps to repel the bees.

You should also avoid using strong perfumes as they attract the bees. Dry and exposed soil is where these bees breed, so you should remember to keep the exposed soil covered. Also, don’t forget to keep away dead wood where the bees are likely to build nests.

Bee Summary

1. Any habitat on the planet that supports flowering plants which are insect-pollinating has bees. This makes Antarctica a place where you can’t spot bees in most numbers.
2. It has been revealed that there are more than 20,000 species of bees on the planet.
3. You know why bees make honey? It is to feed their young ones, especially during winter.
4. There are some bees that die after stinging. This is because their stingers have a little hook on them attached to their stomach. Sadly, part of their abdomen is ripped apart when they try to fly away post-stinging.
5. Bees vary in sizes. While the smallest one Euryglossina (Quasihesma) measures only 2mm, the largest one Megachile/Chalicodoma pluto, is about 4 cm long.
6. FYI, only a few species of bees make honey; not all ‘Killer bees’ look like honey bees; the difference being the size of their wings. They got that name because they attack humans after coming together in a large group, which can be dangerous.
7. From the Bumblebee Conservation Trust in the UK, Richard Comont has said, “No male bee of any species can sting, even honeybees and bumblebees. Only the female ones have that power. Whoa!
8. In Spain, some rock paintings that date back to the 15,000 BC have bees in them.
9. Honey-making species of bees do their own ‘waggle’ dance as a form of communication.

Bees and Related Bee-Like Insects Post Quiz
Fill-In-the-blank

1. Mostly seen hovering bushes and flowers. In its strict application, the name refers to members of the______________, a large family of bees that are common in most of the world except Australia and Southeast Asia, where they are only a minor faunistic element. In the USA, the common species are black, brown, red, or metallic green, and sometimes with yellow markings, and usually 1/4 to 1/2 inch (4-10 mm) in size.

Identifying characteristics for the family Halictidae include:
2. In many species, the tongue is long and pointed, adapted for probing into flowers. All bees are covered with hair, to which pollen sticks when flowers are visited; most female bees have apparatus for gathering this pollen; it is combed into a special basket or brush located on the hind legs. Males do not collect pollen and lack these structures. There are a few species, especially the parasitic bees that have_______________.

Mason Bee
3. Smaller than a honeybee, mason bees resemble ____________more than honeybees. They are deep blue-black in color and have no stripes. Mason bees are native to North America. They are active pollinators between cherry blossom and apple blossom season, and then die out by summer. Attract mason bees by providing them a home. Drill holes exactly 5/16-inch in diameter into wooden blocks and mount the blocks by cherry blossom season facing morning sun.

Orchid Bee Not to be confused with Orchard Bee
4. Male orchid bees have uniquely modified legs which are used to collect and store different volatile compounds (often esters) throughout their lives, primarily from orchids in the sub-tribes Stanhopeinae and Catasetinae, where all species are exclusively pollinated by____________.

5. Different orchid bee males are attracted to different chemicals, so there is also some specificity regarding which orchid bees visit which types of orchid. Not all orchids utilize euglossines as pollen vectors, of course; among the other types of insects exploited are other types of bees, wasps, flies, ants, and moths. The male *Eufriesea purpurata* is highly unusual in actively collecting the _____________in huge amounts from houses in Brazil, without suffering any harm from it.

Cuckoo Bee
6. Cuckoo bees lack any pollen-transporting apparatus (_______________).

7. Many cuckoo bees are closely related to their hosts, and may bear similarities in appearance reflecting this relationship. This common pattern gave rise to the ecological principle known as "____________".

Bumble Bee or Carpenter Bee?

8. When encountering black, almost round bees buzzing around their home most people do not know the difference between the bumble bee and__________________.

Queen Bumble Bee

9. The queen bumble bee comes out of hibernation every ______________to find a new spot to build her nest and start a new colony. The queen bee is fertilized the previous season and has managed to live through the winter months. The same nesting spots (from previous seasons) are rarely used.

Bumble Bee Control

10. Bumble bees are ___________________that pollinate plants and flowers. Their activity in gardens is desirable, but allowing them to nest in areas where children and pets frequent or where you garden is not desirable.

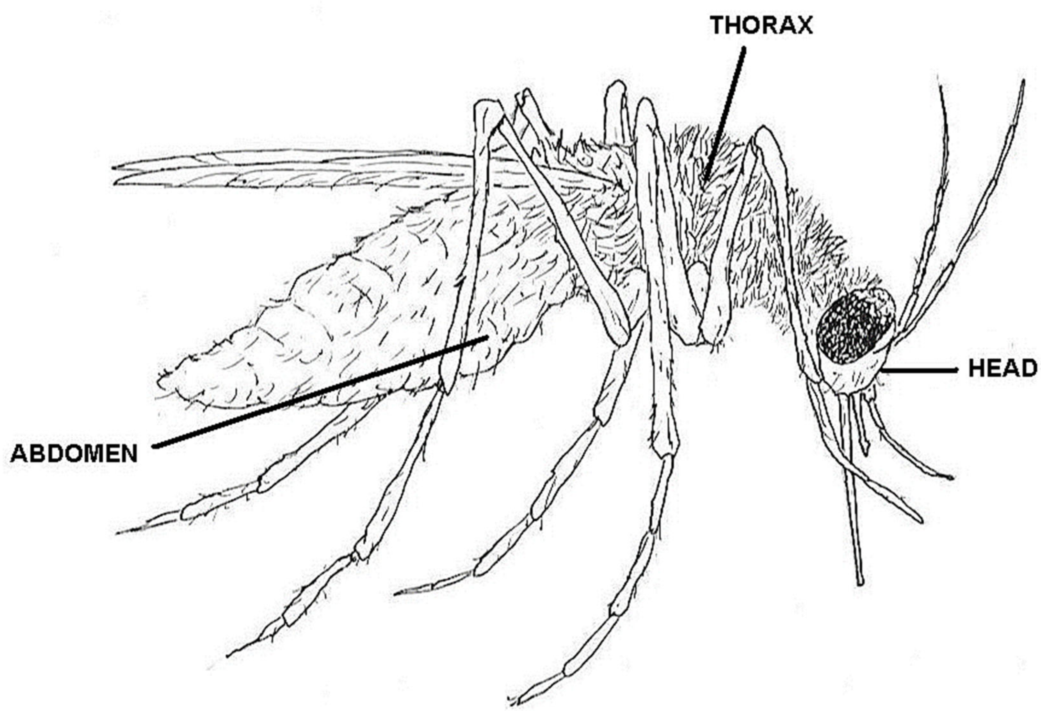
Bees and Related Bee-Like Insects Answers

1. Halictidae, 2. No pollen baskets, 3. House flies, 4. Euglossine males, 5. Insecticide DDT, 6. The scopa, 7. Emery's Rule, 8. Carpenter bee, 9. Spring, 10. Very important, beneficial insects

Topic 4 - Mosquito Section

Section Focus: You will learn the basics of mosquitoes. At the end of this section, you will be able to understand and describe the mosquito. You will learn about the mosquito family class, genera, life cycle and related subjects. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Mosquitoes are the deadliest animal or insect to humans, therefore we must be educated on this target. It is critical that pesticide applicators master control of this pest target in that we do not destroy other wildlife during treatment operations.

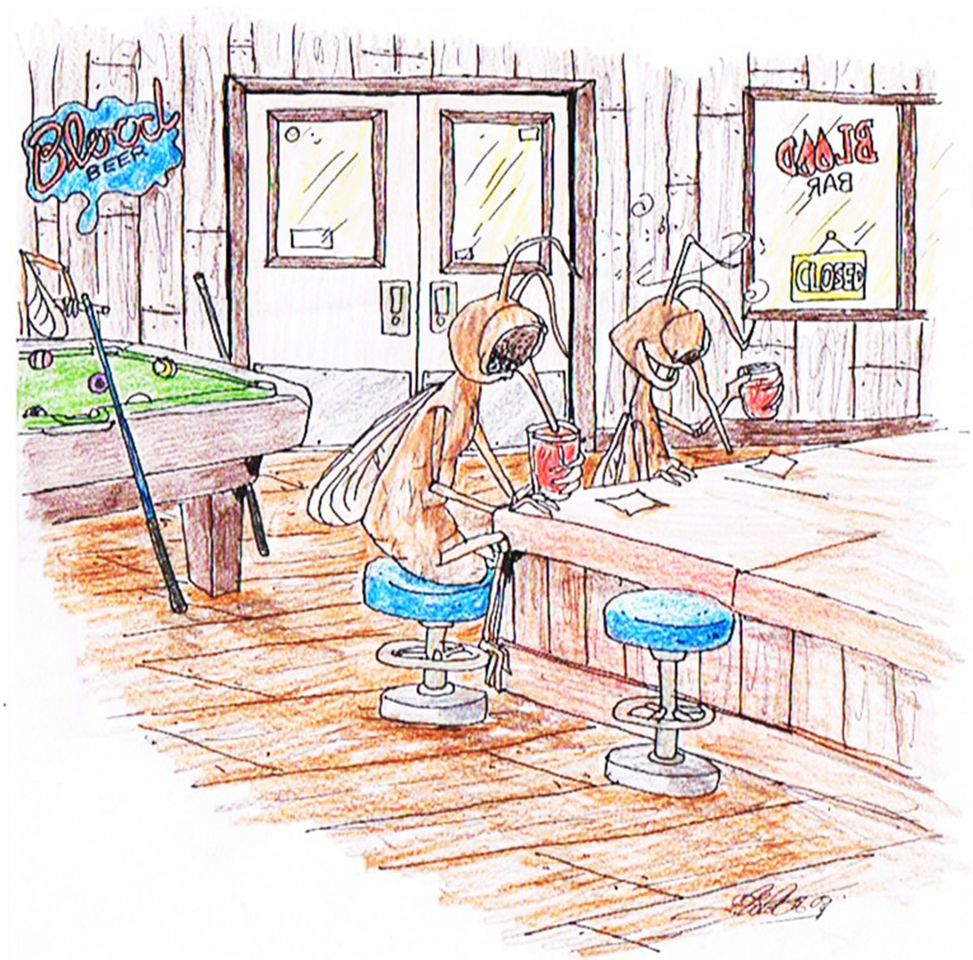


MOSQUITO ANATOMY DIAGRAM #1

Mosquitoes are the #1 killer of humans in the world. About 2 million people die each year from one disease resulting from a mosquito bite. The primarily disease is Malaria, and is caused by a small animal, called a *Plasmodium,* that gets into people through a mosquito bite. We will cover this area in detail in the Mosquito Disease Section.

Only the female mosquito bites humans. She uses protein from blood to make the shells of their eggs. Male and female mosquitoes eat nectar from flowers, like butterflies and hummingbirds. The female mosquitoes have a problem, though, when they try to suck our blood. When our blood gets outside of our body, the cells tend to stick together.

We know this as “clotting” and it's why you get a scab when you cut your skin, its scientific name is "coagulation". Coagulation is a big problem for a mosquito who has a very thin tube through which to suck blood.



Female Mosquito

To combat coagulation, the mosquito first *spits* into us when she bites. The coagulated blood cells clog her tube and she cannot get good blood through it. She spits a chemical called an "anti-coagulant" that keeps the blood cells from sticking together so she can suck as much as she wants! It is during the spitting phase of biting that the Malarial *Plasmodium* gets into us. Once inside a mammal, the *Plasmodium* goes through the bloodstream and into the liver, where it reproduces.

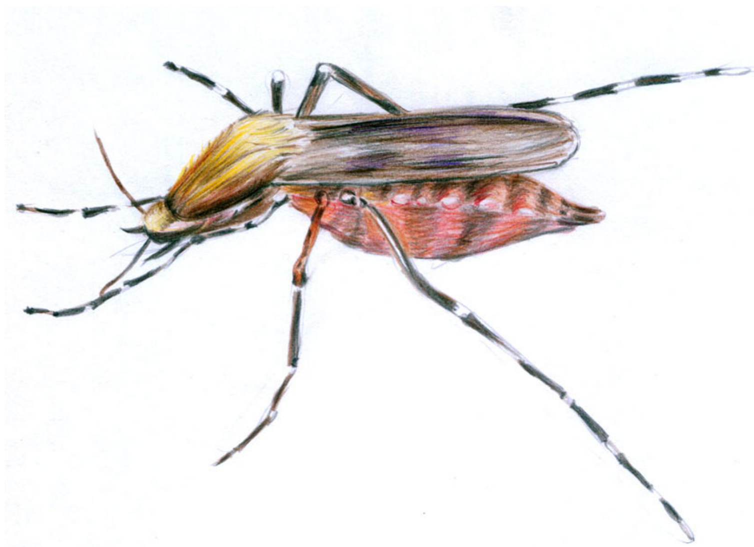
From the liver, the *Plasmodium* cells get into red blood cells and begin to feed. Inside the red blood cells, the *Plasmodium* cells divide and eventually split the red blood cells open, and a bunch of new *Plasmodium* cells infect other red blood cells.

The cycle continues as the host animal gets sicker and sicker, and often dies. Fortunately, the type of *Plasmodium* that causes malaria and the species of mosquito (in the genus *Anopheles* "an-off-eh-lees") that spreads it do not live in the United States, but in many other countries (especially in tropical regions), this is a very dangerous disease. Therefore, a lot of research money is available for the study of malaria and mosquitoes (which also spread other diseases in much the same fashion).

Mosquito Terms and Definitions

Mosquito are Gnats

Any one of various species of gnats of the genus Culex and allied genera. The females have a proboscis containing, within the sheath-like labium, six fine, sharp, needlelike organs with which they puncture the skin of man and animals to suck the blood. These bites, when numerous, cause (in many persons) considerable irritation and swelling, with some pain. The larv[ae] and pup[ae], called wigglers, are aquatic. A mosquito has three body parts; the head, the thorax, and the abdomen. It has six legs, two wings, and two antennae. (The male and female have different antennae.) The part that sucks our blood is called the proboscis.

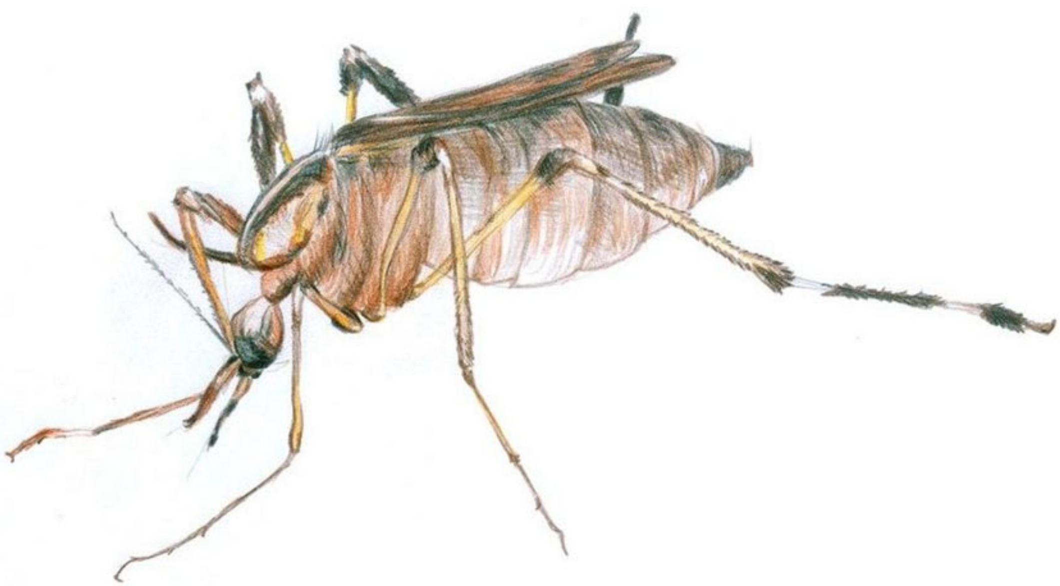


BLOOD ENGORGED FEMALE AEDES MOSQUITO

Term	Definition
Arbovirus	Any of various viruses transmitted by arthropods and including the causative agents of encephalitis, yellow fever, and dengue.
Biological Control	The use of parasites or pathogens to control a pest.
Disease	Condition of the living animal or plant body or of one of its parts that impairs the performance of a vital function.
Encephalomyelitis	Concurrent inflammation of the brain and spinal cord.
Monitoring	Method in which an area is appraised for its mosquito numbers and/or evidence of disease agents within the mosquito population.
Pathogen	Specific causative agent of disease.
Reservoir	Organism in which a parasite that is pathogenic for some other species lives and multiplies without damaging its host.
Surveillance	Method in which an area is appraised for its risk of providing mosquito breeding grounds and subsequent mosquito populations.
Vector	Organism that transmits a pathogen.

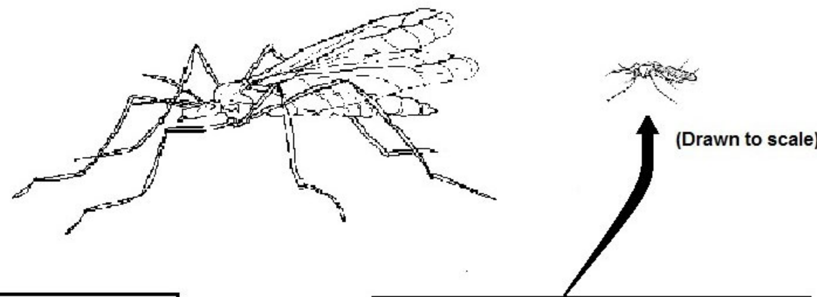
AEDES VEXANS

Floodwater mosquitoes, such as *Aedes vexans,* lay their eggs in damp places just above the water line of temporary ponds. The eggs hatch after a warm rain and may produce a new generation of adults in as little as a week. Eggs can also remain dormant for over two years during drought conditions. The adults will die from desiccation if exposed to dry sunny conditions and will only emerge from wooded areas at dusk or on dull, humid days.



PSOROPHORA CILIATA

Psorophora ciliata is found only during wet summers when other mosquitoes are abundant. Their larvae are carnivorous and each one consumes dozens of smaller mosquito larvae.



CRANE FLY

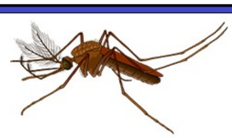
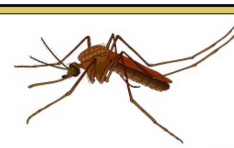
- LOCAL GENUS: Tipula ultima
- SIZE: 3/8 to 2 1/2 inch
- HABITAT: Humid Areas
- HARMLESS TO HUMANS
- ADULTS ARE A FAVORITE FOOD OF MANY BIRDS AND SMALL MAMMALS

MOSQUITO

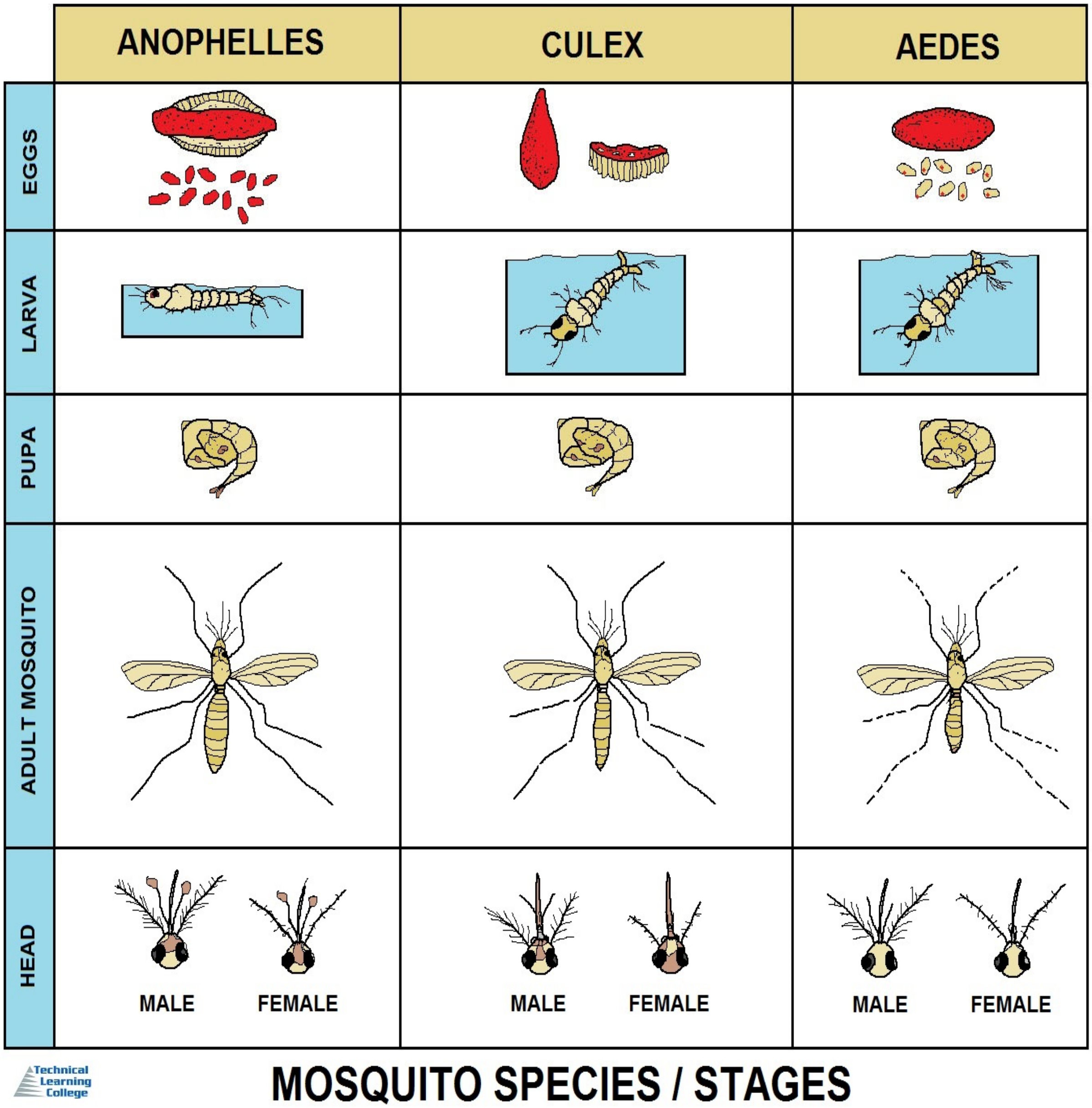
- LOCAL GENUS: Culex pipiens
- SIZE: 1/8 to 1/4 inch
- HABITAT: Any still water
- CAN BE HARMFUL TO HUMANS AS THEY MAY CARRY VARIOUS TYPES OF DISEASES

Technical Learning College

CRANE FLY / MOSQUITO COMPARISON

 MALE MOSQUITO	 FEMALE MOSQUITO
USUALLY LIVE FOR ONE TO TWO WEEKS	USUALLY LIVE FOR A FEW DAYS
HAVE BUSHY PROBOSCISES	HAVE SMOOTHER AND NEEDLE-LIKE PROBOSCISES
HAVE FEATHER-LIKE HAIR ON THEIR ANTENNAE	DOES NOT HAVE FEATHER-LIKE HAIR ON THEIR ANTENNAE
OFTEN QUITE SMALLER	OFTEN BIGGER
SUCK FRUIT AND NECTAR JUICE	SUCK BLOOD, NECTAR AND FRUIT JUICE
TEND TO HATCH EARLY	TEND TO HATCH LATER
DOES NOT CARRY DISEASES	CARRY DISEASES
BUZZ AT A LOWER PITCH	BUZZ AT A HIGHER PITCH
TEND TO STAY AWAY FROM HUMANS	MORE PROXIMAL TO HUMANS
PRIMARY ROLE IS TO CARRY SPERM	ROLES ARE TO MATE AND CARRY, FERTILIZE & LAY EGGS
CAN MATE MANY TIMES	MATES ONLY ONCE
LESS LIKELY TO TAKE OFF IN RESPONSE TO INSECT REPELLENTS	LIKELY TO TAKE OFF IN RESPONSE TO INSECT REPELLENTS

MALE / FEMALE MOSQUITO COMPARISON CHART #1



MOSQUITO SPECIES / STAGES

World’s Deadest Insect/Animal of all Time

Mosquitoes are estimated to transmit disease to more than 700 million people annually in Africa, South America, Central America, Mexico, Russia and much of Asia with millions of resulting deaths. At least 2 million people annually die of these diseases. Mosquitoes are a vector agent that carries disease-causing viruses and parasites from person to person without exhibiting symptoms themselves.

The principal mosquito borne diseases are the viral diseases yellow fever, dengue fever and Chikungunya, transmitted mostly by the Aedes aegypti, and malaria carried by the genus Anopheles. Though originally a public health concern, HIV is now thought to be almost impossible for mosquitoes to transmit.

Methods used to prevent the spread of disease, or to protect individuals in areas where disease is endemic include Vector control aimed at mosquito eradication, disease prevention, using prophylactic drugs and developing vaccines and prevention of mosquito bites, with insecticides, nets and repellents. Since most such diseases are carried by "elderly" females, scientists have suggested focusing on these to avoid the evolution of resistance

Mosquito control requires knowledge of the behavioral and habitat differences among species in order to plan and carry out a treatment program. The trained worker first identifies the problem species. With identity established, useful correlations are immediately available, such as the type of breeding habitat and where to search for larvae. A working knowledge of the behavior and habitats frequented by various species aids in determining the kinds of survey and control strategies best suited for the task. Mosquitoes are not adapted to life in moving waters, but they can occupy the quiet pools and seepage areas near flowing streams.

Integrated Pest Management -Introduction
The Centers for Disease Control (CDC) and the U.S. Environmental Protection Agency (EPA) collaborate on mosquito control activities throughout the United States to control diseases. By looking at biological information about the life and reproduction of the mosquito and epidemiological information about the disease, the two organizations have developed a methodology on how best to control mosquitoes. Both CDC and EPA are helping Puerto Rico apply this methodology to develop a successful, sustainable program and approach to controlling mosquitoes that transmit Zika, dengue, chikungunya, and other diseases.

Successful mosquito management requires intervening at some point during the mosquito’s life cycle before they bite and infect a human. The best approach to controlling mosquitoes takes advantage of every life stage of a mosquito to achieve control, using a unified approach referred to as integrated pest management (IPM).

EPA and CDC encourage all communities and mosquito control districts, including those in territories like Puerto Rico, to strictly adhere to IPM. IPM is a science-based, common-sense approach for managing pests and vectors, such as mosquitoes.

IPM uses a variety of pest management techniques that focus on pest prevention, pest reduction, and the elimination of conditions that lead to pest infestations. IPM programs also rely heavily on resident education and pest monitoring.

A successful IPM strategy can use pesticides. IPM uses a combination of ways to control mosquito populations with decisions based on surveillance, such as keeping track or count of the numbers and types of mosquitoes in an area. Surveillance is a critical component to any successful IPM program because the results from the surveillance will help determine the appropriate response to an infestation. Extensive infestations, or those where disease is present, merit a different response than will lower levels of infestations.

Both CDC and EPA recognize a legitimate and compelling need for the use of chemical interventions, under certain circumstances, to control adult mosquitoes. This is especially true during periods of mosquito-borne disease transmission or when source reduction and larval control have failed or are not feasible.

Puerto Rico
Puerto Rico has been actively working to control mosquitoes that transmit Zika (and dengue and chikungunya) for about six months; however, mosquito populations are increasing and additional methods are needed to control the mosquitoes during their adult stage.

A successful integrated mosquito control strategy includes several tactics to eliminate mosquitoes and their habitat.

Four critical tactics include:
1. Remove Mosquito Habitats
2. Use Structural Barriers
3. Control Mosquitoes at the Larval Stage
4. Control Adult Mosquitoes

Aquatic Environment Introduction

Aquatic environments differ chiefly in the chemistry of the water (acid or alkaline; fresh, salt or brackish). These environments may be natural or man-made and may also differ in the amount or type of vegetation present and the amount of sun or shade. Coquillettidia perturbans, Mansonia dyari and Ma. titillans, for example, are found in association with specific aquatic plants — water lettuce, water hyacinth and cattails. Wyeomyia spp. are found in association with bromeliads and pitcher plants. In this regard, the distinctive egg-laying habit of each species of mosquito determines its larval habitat.

Although some species use more than one type of habitat, most mosquitoes can be categorized in general terms by their preference for either permanent water, floodwater, transient water or artificial container and tree-hole habitats. These categories can be combined into two major larval habitat categories: standing water (permanent and transient) and floodwater (including natural and artificial containers as well as floodwater).

Standing water species deposit their eggs (either singly or in rafts) on the surface of permanent or transient pools of standing water. They usually produce several generations (broods) each year and overwinter or survive harsh environmental circumstances as mated, engorged females. In contrast, floodwater species deposit their eggs out of the water but in locations subject to periodic flooding, such as damp soil in depressions or inside tree holes, crab holes and artificial containers.

They produce one to several broods annually and overwinter or survive harsh environmental circumstances in the egg stage. Mosquitoes are adaptable to changing environmental conditions and are thus associated with multiple habitat types.

Why do Mosquitoes Bite?
Mosquitoes belong to a group of insects that require blood to develop fertile eggs. Males do not lay eggs, thus, male mosquitoes do not bite. The females are the egg producers and "*host-seek*" for a blood meal. Female mosquitoes lay multiple batches of eggs and require a blood meal for every batch they lay. Few people realize that mosquitoes rely on sugar as their main source of energy.

Both male and female mosquitoes feed on plant nectar, fruit juices, and liquids that ooze from plants. The sugar is burned as fuel for flight and is replenished on a daily basis. Blood is reserved for egg production and is imbibed less frequently.

Why do Mosquitoes Leave Welts When They Bite?
When a female mosquito pierces the skin with her mouthparts, she injects a small amount of saliva into the wound before drawing blood.

Adult mosquitoes are terrestrial and capable of flight. With piercing-sucking mouthparts, the females feed mostly on animal blood and plant nectar. Males' antennae have dense bristles, and their mouthparts are modified to suck nectar and plant secretions, where no piercing is required. The adults of some species remain within a few hundred feet of where they spent the larval stage, whereas others may migrate up to 50 miles or more. Eggs develop a few days after females take a blood meal. Females oviposit on the water, in crevices in the soil, or on other favored substrates or special niches that are or will subsequently be flooded, such as natural and artificial containers or tree holes, and the cycle repeats itself.

Females of some floodwater species may live up to a month after they emerge, whereas those of some permanent water or standing water species can survive for several months by overwintering as mated, engorged adults. Some species, including those whose eggs require freezing temperatures, are limited to a single generation per year, whereas others have multiple generations.

Those casually acquainted with mosquitoes may believe that all types are much the same, and, indeed, the similarities between species is considerable. There are, however, many differences in appearance from species to species and even among some varieties within species.

These morphological differences, especially notable in the larval and adult stages, permit accurate identification of most species. Behavioral differences permit various species to occupy numerous ecological niches with relatively little overlap. Thus, knowledge of the source or breeding habitat of mosquitoes can provide strong clues to their identification.

Why are some People More Attractive to Mosquitoes than others?
Scientists are still investigating the complexities involved with mosquito host acceptance and rejection. Some people are highly attractive to mosquitoes and others are rarely bothered. Mosquitoes have specific requirements to satisfy and process many different factors before they feed.

Many of the mosquito's physiological demands are poorly understood and many of the processes they use to evaluate potential blood meal hosts remain a mystery. Female mosquitoes use the CO_2 we exhale as their primary cue to our location. A host-seeking mosquito is guided to our skin by following the slip stream of CO_2 that exudes from our breath.

Short Range Attractants
Once they have landed, they rely on a number of short-range attractants to determine if we are an acceptable blood meal host. Folic acid is one chemical that appears to be particularly important. Fragrances from hair sprays, perfumes, deodorants, and soap can cover these chemical cues. They can also function to either enhance or repel the host-seeking drive. Dark colors capture heat and make most people more attractive to mosquitoes. Light colors refract heat and are generally less attractive to mosquitoes. Detergents, fabric softeners, perfumes and body odor can counteract the effects of color. In most cases, only the mosquito knows why one person is more attractive than another.

How Long Do Mosquitoes Live?
Mosquitoes are relatively fragile insects with an adult life span that lasts about 2 weeks. The vast majority meets a violent end by serving as food for birds, dragonflies, and spiders, or are killed by the effects of wind, rain or drought. The mosquito species that only have a single generation each year are longer lived and may persist in small numbers for as long as 2-3 months if environmental conditions are favorable. Mosquitoes that hibernate in the adult stage live for 6-8 months, but spend most of that time in a state of torpor. Some of the mosquito species found in arctic regions enter hibernation twice and take more than a year to complete their life cycle.

What Happens When Mosquitoes Bite?
The saliva makes penetration easier and prevents the blood from clotting in the narrow channel of her food canal. The welts that appear after the mosquito leaves is not a reaction to the wound but an allergic reaction to the saliva injected to prevent clotting. In most cases, the itching sensation and swellings subside within several hours. Some people are highly sensitive and symptoms persist for several days. Scratching the bites can result in infection if bacteria from the fingernails are introduced to the wounds.

Where do mosquitoes go in the winter?
Mosquitoes, like most insects, are cold-blooded creatures. As a result, they are incapable of regulating body heat, and their temperature is essentially the same as their surroundings. Mosquitoes function best at 80^{o}F, become lethargic at 60^{o}F and cannot function below 50^{o}F.

Saliva
In order for the mosquito to obtain a blood meal it must circumvent the vertebrate physiological responses. The mosquito, as with all blood-feeding arthropods, has mechanisms to effectively block the hemostasis system with their saliva, which contains a mixture of secreted proteins. Mosquito saliva negatively affects vascular constriction, blood clotting, platelet aggregation, angiogenesis and immunity and creates inflammation. Universally, hematophagous arthropod saliva contains at least one anticlotting, one anti-platelet, and one vasodilatory substance. Mosquito saliva also contains enzymes that aid in sugar feeding and antimicrobial agents to control bacterial growth in the sugar meal. The composition of mosquito saliva is relatively simple as it usually contains fewer than 20 dominant proteins.

Despite the great strides in knowledge of these molecules and their role in blood feeding achieved recently, scientists still cannot ascribe functions to more than half of the molecules found in arthropod saliva. One promising application is the development of anti-clotting drugs based on saliva molecules, which might be useful for approaching heart-related disease, because they are more user-friendly blood clotting inhibitors and capillary dilators.

Modulate the Immune Response
It is now well recognized that the feeding ticks, sandflies, and, more recently, mosquitoes have an ability to modulate the immune response of the animals (hosts) they feed on. The presence of this activity in vector saliva is a reflection of the inherent overlapping and interconnected nature of the host hemostatic and inflammatory/immunological responses and the intrinsic need to prevent these host defenses from disrupting successful feeding. The mechanism for mosquito saliva-induced alteration of the host immune response is unclear, but the data has become increasingly convincing that such an effect occurs.

Early work described a factor in saliva that directly suppresses TNF release, but not antigen-induced histamine secretion, from activated mast cells. Experiments by Cross et al. (1994) demonstrated that the inclusion of Ae. aegypti mosquito saliva into naïve cultures led to a suppression of interleukin (IL)-2 and IFN production, while the cytokines IL-4 and IL-5 are unaffected by mosquito saliva. Cellular proliferation in response to IL-2 is clearly reduced by prior treatment of cells with SGE.

Correspondingly, activated splenocytes isolated from mice fed upon by either Ae. aegypti or Cx. pipiens mosquitoes produce markedly higher levels of IL-4 and IL-10 concurrent with suppressed IFN production. Unexpectedly, this shift in cytokine expression is observed in splenocytes up to 10 days after mosquito exposure, suggesting that natural feeding of mosquitoes can have a profound, enduring, and systemic effect on the immune response.

Mosquito Genera Introduction

Genera or Genus Definition
A principal taxonomic category that ranks above species and below family, and is denoted by a capitalized Latin name, e.g. Leo.

How Many Kinds of Mosquitoes Are There?
About 3,000 species of mosquitoes have been described on a world-wide basis. Approximately 150-200 are known to occur in North America. Scientists group species by genus on the basis of the physical characteristics they share.

The 3,000 mosquito species found in the world are divided among 28 different genera. The genus *Aedes* contains some of the worst pests. Many members of the genus *Anopheles* have the ability to transmit human malaria.

Mosquito Genera
Here are just a few major genera that occur in the United States: *Aedes*, *Anopheles*, *Culex*, *Culiseta*, *Coquillettidia*, *Psorophora*, *Orthopodomyia*, *Uranotaenia*, *Toxorhynchites* and *Wyeomyia*. It is sometimes more convenient to group mosquitoes by the breeding habitat they use.

The major habitat groups found include: "*Snowpool Mosquitoes,* "*Floodwater Mosquitoes,"* "*Swamp Breeding Mosquitoes,*" and "*Container Breeding Mosquitoes.*

Common Name	Scientific Name	Importance
Asian Tiger Mosquito	Aedes albopictus	LAC, EEE, SLE, Pest
Banded spring mosquito	Aedes canadensis	LAC, Pest
Eastern Treehole Mosquito	Aedes triseriatus	LAC
Flood-water mosquito	Aedes tivittatus	Pest
Vexans Mosquito	Aedes vexans	Pest
Common Malaria Mosquito	Anopheles quadrimaculatus	Malaria, Pest
Cattail Mosquito	Coquillettidia perturbans	EEE, Pest
Northern House Mosquito	Culex pipiens	SLE
Key: **LAC** = LaCrosse Encephalitis **EEE** = Eastern Equine Encephalomyelitis **SLE** = St. Louis Encephalitis		

Mosquito Family, Subfamily, Genus and Related Classifications

Aedes
Aedes is a genus of mosquito originally found in tropical and subtropical zones, but now found on all continents excluding Antarctica. Some species have been spread by human activity. Aedes albopictus, a most invasive species was recently spread to the new world, including the US, by the used tire trade. First described and named by Meigen in 1818, the name comes from the Ancient Greek word, meaning "unpleasant" or "odious". Some species of this genus transmit serious diseases, including dengue fever and yellow fever. In Polynesia, the species Aedes polynesiensis is responsible for the transmission of human lymphatic filariasis including species of Brugia as well as others. Aedes can be detected and monitored by Ovitraps.

Anopheles (Genus)
Subfamily Anophelinae. A total of 465 formally recognized species and more than 50 unnamed members of species complexes are recognized as distinct morphological and/or biological species of the genus. The formally named species are placed in seven subgenera, Anopheles (182 species), Baimaia (1), Cellia (217), Kerteszia (12), Lophopodomyia (6), Nyssorhynchus (35) and Stethomyia (5).

World-Wide Distribution
Anopheles has an almost world-wide distribution. Species of the genus occur in temperate, subtropical and tropical areas, but are absent from the majority of the Pacific Islands, including the large ones of New Zealand, Fiji and New Caledonia, and isolated islands in the Atlantic. Anopheles species are found at elevations from coastal areas to mountainous terrain.

Mosquitoes of genus Anopheles are the sole vectors of human malarial parasites. Some species are effective vectors of microfilariae and some may be involved in the transmission of encephalitis viruses. Anopheles are vectors of numerous animal pathogens, including species of malaria protozoa that do not affect humans.

Largest Subgenus
Cellia is the largest subgenus with all species occurring in the Old World. The subgenus is segregated into six Series (Cellia, Neocellia, Myzomyia, Neomyzomyia, Paramyzomyia and Pyretophorus). Each series contains vectors of malarial protozoa and microfilariae. The most important malaria vectors include An. arabiensis, An. funestus, An. gambiae and An. moucheti in the Afrotropical Region; An. balabacensis, An. baimaii, An. culicifacies, An. dirus, An. latens, An. leucosphyrus, An. maculatus, An. minimus, An. fluviatilis s.l., An. sundaicus and An. superpictus in the Oriental Region; members of the An. farauti and An. punctulatus complexes in the Australasian Region; An. sergentii and An. stephensi in the Middle East and the Indian Subcontinent.

Anopheles
Subgenus Anopheles is also divided into six series, but only the Myzorhynchus and Anopheles Series contain vector species. Some primary vectors of historical and contemporary importance in the transmission of malaria protozoa include An. freeborni in western North America, An. sinensis in southeastern areas of the Palaearctic Region, An. atroparvus in Europe and eastern Asia, and An. pseudopunctipennis at higher elevations in Central and South America.

Nyssorhynchus
Subgenus Nyssorhynchus contain species that are variously distributed from Argentina to the southern USA. Anopheles albimanus, An. aquasalis, An. argyritarsis, An. darlingi and An. nuneztovari are vectors of malarial protozoa. Anopheles albitarsis and An. aquasalis also transmit arboviruses, and some species also transmit Wuchereria bancrofti.

Kerteszia
Subgenus Kerteszia occurs in Central and South America. Six species are known to transmit malarial protozoa, but only An. bellator in Trinidad and An. cruzii in Brazil are important vectors. Anopheles bellator also transmits the helminths that cause Bancroftian filariasis.

Species of the remaining subgenera, Baimaia in the Oriental Region and Stethomyia and Lophopodomyia in the Neotropical Region, are not of medical importance to humans.

Anophelinae (Genus subfamily)
Subfamily Anophelinae includes 478 formally recognized species. Many genetic species of sibling species complexes await formal names. The subfamily is divided into three genera: Anopheles, Bironella and Chagasia. Mosquitoes belonging to these genera are referred to as 'anophelines' Most species of the subfamily belong to genus Anopheles, which occurs in temperate, subtropical and tropical areas of the world except for island groups in the Pacific and isolated islands in the Atlantic. Bironella and Chagasia are small genera, restricted to the Australasian and Neotropical Regions, respectively. Adult anophelines are easily recognized by their appearance. Most species stand with the body inclined at an angle of 30-45° to the surface and have dark and pale spots of scales on the veins of the wings. Some species have the wing veins entirely covered with dark scales. The maxillary palpi of both sexes are about as long as the proboscis (except in Bironella). The palpi of females sometimes have semi-erect scales that give them a rather shaggy appearance. The scutellum is evenly rounded in Anopheles and Bironella and tri-lobed in Chagasia. The abdominal sterna, and usually the terga, are completely or nearly devoid of scales. Anopheline larvae lack a respiratory siphon, the head is longer than wide and pairs of palmate setae are normally present on some or all of abdominal segments I-VII.

Chagasia (Genus)
Chagasia is a small genus of only five species. Four species of Chagasia are restricted to South America and one (Ch. bathana) extends from Ecuador, Colombia and Venezuela through Central America into southern Mexico. Chagasia has been considered an ancient group showing affinities with non-anophelines. Cladistic analyses of morphological data and DNA sequences of various ribosomal, mitochondrial and nuclear genes strongly support the monophyly of Chagasia and its placement in an ancestral relationship to all other anophelines.

Similar to Anopheles
The adults of Chagasia are similar to those of Anopheles, but the resting posture is like culicine mosquitoes with the head and abdomen at angles to the thorax, and the scutellum is tri-lobed with setae in three distinct groups. The wings have dark scales or a mixture of dark and pale scales, but there are no distinct spots as there are in most Anopheles. Larvae have uniquely shaped palmate setae (seta 1) on abdominal segments III-V, and the spiracular apparatus bears a long median process and a fringe-like row of setae on either side. See Anophelinae.

Chagasia larvae are usually found in shaded streams among the roots of trees and in grassy margins or dead leaves and other debris.

They sometimes occur in clear rock-pools along shaded streams. Adults remain in vegetation near the larval habitats or enter nearby forest canopy. Females bite during the day and night, but seldom feed on humans. Species of Chagasia are not known to transmit any pathogens of human diseases.

Chironomidae (Chironomidae family) (Non-Biting Midges)
Chironomidae (informally known as chironomids or non-biting midges) are a family of nematoceran flies with a global distribution. They are closely related to the Ceratopogonidae, Simuliidae, and Thaumaleidae. Many species superficially resemble mosquitoes but they lack the wing scales and elongate mouthparts of the Culicidae. This is a large group of insects with over 5000 described species and 700 species in North America alone.

Plumose Antennae
Males are easily recognized by their plumose antennae. Adults are sometimes known as "lake flies" in parts of Canada, as "sand flies", "muckleheads", or "muffleheads" in various regions of the USA Great Lakes area, and as "blind mosquitoes" or "chizzywinks" in Florida, USA. Their amazing biodiversity often goes unnoticed because Chironomidae are notoriously difficult to identify and are usually recorded by species groups by ecologists. Each morphologically distinct group consists of a number of morphologically (sibling) identical species that can only be identified by rearing adult males or by cytogenetic analysis of the polytene chromosomes.

Polytene chromosomes were originally observed in the larval salivary glands of Chironomus midges by Balbiani in 1881. They form through repeated rounds of DNA replication without cell division, resulting in characteristic light and dark banding patterns which can be used to identify inversions and deletions which allow species identification.

Bloodworms
Larval stages of Chironomidae can be found in almost any aquatic or semiaquatic habitat, including treeholes, bromeliads, rotting vegetation, soil, and in sewage and artificial containers. They form an important fraction of the macro zoobenthos of most freshwater ecosystems. They are often associated with degraded or low biodiversity ecosystems because some species have adapted to virtually anoxic conditions and are dominant in polluted waters. Larvae of some species are bright red in color due to a hemoglobin analog; these are often known as "bloodworms". Their ability to capture oxygen is further increased by making undulating movements.

Adults can be pests when they emerge in large numbers. They can damage paint, brick, and other surfaces with their droppings. When large numbers of adults die they can build up into malodorous piles. They can provoke allergic reactions in sensitive individuals

Culex
Carl Linnaeus used the Latin term for midge or gnat, culex, as the name of this taxon. Culex is a genus of mosquito, and is important in that several species serve as vectors of important diseases, such as West Nile virus, filariasis, Japanese encephalitis, St. Louis encephalitis and avian malaria. The adult mosquito can measure from 4–10 millimeters (0.16–0.39 in), and morphologically has the three body parts common to insects: head, thorax, and abdomen.
As a fly, it has one pair of wings. Scientists at the University of California, Davis and the Swedish University of Agricultural Sciences (SLU), have identified nonanal as a compound that attracts Culex mosquitoes. Nonanal acts synergistically with carbon dioxide.

The developmental cycle takes two weeks and is by complete metamorphosis. Eggs are laid singularly or in batches, depending on the species. Eggs will only hatch in the presence of water. During the larval stage the mosquito lives in water and feeds on organic matter and plants, then develops into a pupa. The pupa is comma-shaped and also lives in water. It does not feed and becomes an adult after one or two days.

Culex Tarsalis

Tarsalis is a North American species of mosquito that occupies a large swath of territory between northern Mexico and southern Canada, spreading from the Pacific to the Atlantic coast. It is most commonly seen in California, at elevations ranging as high as 3000 meters. The species is much less abundant in areas east of the Mississippi River, although there have been several reported cases of C. tarsalis occurrences as far as New Jersey, which were found exploiting freshwater impoundments constructed to eliminate the salt marsh species Aedes sollicitans. (Crans and McCuiston, 1987; Reisen, 1993)

Associated Species

Larval habitats frequently are shared with Culiseta inornata, Culex quinquefasciatus, Cx. pipiens and Cx. stigmatosoma; other species include Culex erythrothorax, Cx. restuans and several species of Aedes and Anopheles.

Rafts

Rafts averaging about 190 eggs are oviposited in newly-created sunlit surface water pools that are frequently surrounded by grasses and annual vegetation. Larvae tolerate a wide range of water conditions and may be abundant in agricultural tailwater, alkaline lake beds, fresh and saline wetlands, secondary treated sewage effluent and oil field run-off. Permanent water with fixed depth rarely supports abundant populations unless intermittently perturbated. Excessive organic pollution is not tolerated.

Cx. tarsalis are among the first colonizers of newly-created surface pools and thus exploit microfloral blooms produced by the release of nutrients from decomposing vegetation. Larval development ranges from 7 days to <4 weeks and progresses as a curvilinear function of water temperature and food availability. Larval survivorship is typically <5%, with most losses attributable to predation. Some females mature their initial egg batch without a blood meal and oviposit 4-5 days after emergence. The frequency of this trait is dependent upon temperature, photoperiod and nutrition and affects the vectorial capacity of a population. At northern latitudes, females overwinter in facultative diapause as inseminated nullipars (never developed eggs) that require a blood meal to produce their initial eggs in the spring.

Blood Feeding

In spring, when population abundance is low, most females feed on birds shortly after sunset. During late summer when abundance is high, bird mosquito-avoidance behavior diverts many females to feed on mammals including rabbits, horses, cattle and man. This host shift may be important in virus transmission to horses and man. Dispersal is primarily during host-seeking flights (up to 17 miles) which average about l00 yards a day from breeding sites in riparian and agricultural habitats.

Culicidae (Mosquito family)

Mosquitoes undergo complete metamorphosis with four stages. The female mosquito lays her eggs on the surface of fresh or standing water; some species lay eggs on damp soil prone to inundation. Larvae hatch and live in the water, most using a siphon to breathe at the surface. Within one to two weeks, the larvae pupate. Pupae cannot feed, but can be active while floating on the water's surface. Adults emerge, usually in just a few days, and sit on the surface until they are dry and ready to fly. Adult females live two weeks to two months; adult males may only live a week.

Identifying characteristics for the family Culicidae include:

- Antennae with 6 or more segments (suborder Nematocera), plumose on males and short-haired on females.
- Proboscis long.
- Wings with scales on veins and along the margins.

Additional information:

- Females vector pathogens of major diseases including malaria (protozoan), yellow fever (virus), filariasis (nematode), dengue (virus), and certain types of encephalitis (virus).
- Larvae are aquatic, most feeding on algae, protozoans, and organic debris; a few species are predaceous on other mosquito larvae.
- Males and females feed on nectar and plant juices. Only females feed on blood.
- There are about 150 species of mosquitoes in North America.
- Yellow fever decimated the French army stationed in Haiti, contributing to Napoleon's decision to sell Louisiana to the United States in 1803 and assisting the Haitians in securing their independence in 1804.

Mansonia

Adults of Mansonia are generally large mosquitoes characterized by the presence of broad, asymmetrical scales on the wing veins. There is often a mixture of dark and pale scales that imparts a speckled appearance to the wings. Mansonia resemble some species of Culex, Aedini and Coquillettidia, but the tarsal claws are simple, the abdomen is truncate in females (distinctions from aedine genera), pulvilli are not evident (distinction from Culex) and postspiracular setae are present (distinction from Old World species of Coquillettidia).

New World species of Coquillettidia possess postspiracular setae, but differ from Mansonia in having a conspicuous preapical white band on the anterior surface of the femora. The larvae of Mansonia resemble those of Coquillettidia in having the spiracular apparatus and siphon distinctively modified for piercing plant tissues. They differ from Coquillettidia in having the distal part of the antenna fused with and much shorter than the basal part.

Mansonia titillans of subgenus Mansonia is an important pest in South and Central America and in the southern USA. It is known to transmit various arboviruses, including Venezuelan equine encephalitis.

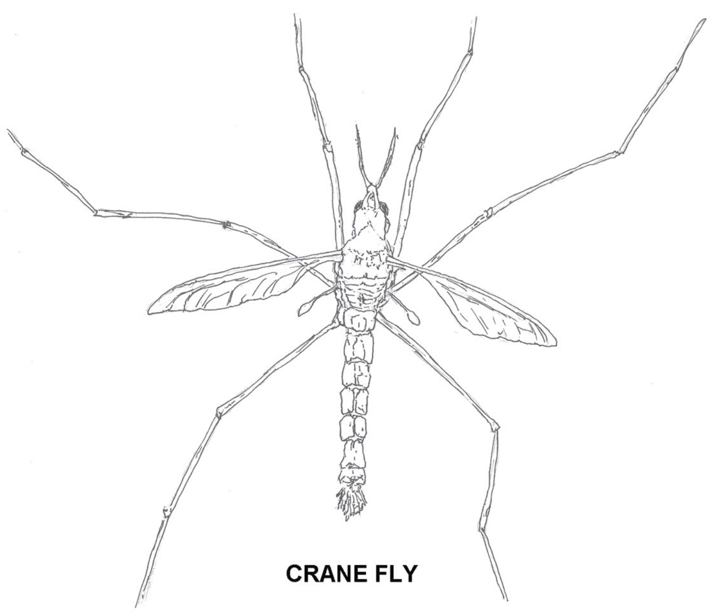
Some species of subgenus Mansonioides transmit several arboviruses, but they are mainly important as vectors of the helminths that cause Brugian filariasis in India and Southeast Asia. Mansonia uniformis, which is widely distributed from western Africa through southern Asia to Japan and the Australasian Region, is a vector of Wuchereria bancrofti in Western New Guinea. Mansonia and Coquillettidia larvae do not have to breathe at the water surface like most others. They have a sharp pointed siphon to pierce the roots or stems of aquatic plants for oxygen.

Phlebotominae (Sand Flies Family)
Members of the subfamily Phlebotominae are known outside of the United States by the name sand fly. This subfamily includes numerous genera of blood-feeding (hematophagous) flies, including the primary vectors of leishmaniasis, bartonellosis and pappataci fever. In the New World, leishmaniasis is spread by sand flies of the genus Lutzomyia, which are common inhabitants of caves, where they feed on bats. In the Old World, the disease is spread by sand flies of the genus Phlebotomus.

Female Sand Flies
Female sand flies suck blood from many warm-blooded animals because the blood helps them to make eggs. Only female sand flies bite, and use their mouthparts to create a pool of blood, which is then sucked up. They inject histamine to prevent blood clotting, similar to the feeding habits of a female mosquito. Females lay their eggs in humid soil rich in organic matter.

One blood meal can result in the creation of up to 100 eggs. Sand flies are small (with a body size of about 3mm in length), making them hard to detect. Their bite is sometimes not felt and leaves a small round, reddish bump that starts itching hours or days later. Use of insect repellent is recommended in areas where sand flies are present.

Tipulidae (Crane Fly Family)



CRANE FLY

Genera and Important Mosquito species in the United States (Family Culicidae)

Only the most important species in each genus are listed by name.
Subfamily Anophelinae (anophelines)

Genus Anopheles 17 spp.
albimanus, bradleyi, crucians, franciscanus, freeborni, hermsi, psuedopunctipennis, punctipennis, quadrimaculatus spp. complex, walkeri.
Subfamily Culicinae (culicines)

Genus Aedes 4 spp.
aegypti, albopictus, cinereus, vexans

Genus Coquillettidia 1 spp.
perturbans

Genus Culex 29 spp. & subspecies
erraticus, nigripalpus, peccator, pipiens, pilosus, quinquefasciatus, restuans, salinarius, stigmatosoma, tarsalis

Genus Culiseta 8 spp.
incidens, inornata, melanura

Genus Deinocerites 3 spp.
cancer, mathesoni, pseudes

Genus Haemogogus 1 spp.

Genus Mansonia 2 spp.
dyari, titillans

Genus Ochlerotatus 77 spp.
abserratus, atlanticus, canadensis, cataphylla, communis, deserticola, dorsalis, excrucians, fitchii, hexadontus, increpitus, monticola, nigromaculis, punctor, sierrensis, sollicitans, spencerii, sticticus, stimulans, taeniorhynchus, triseriatus, trivittatus, varipalpus,

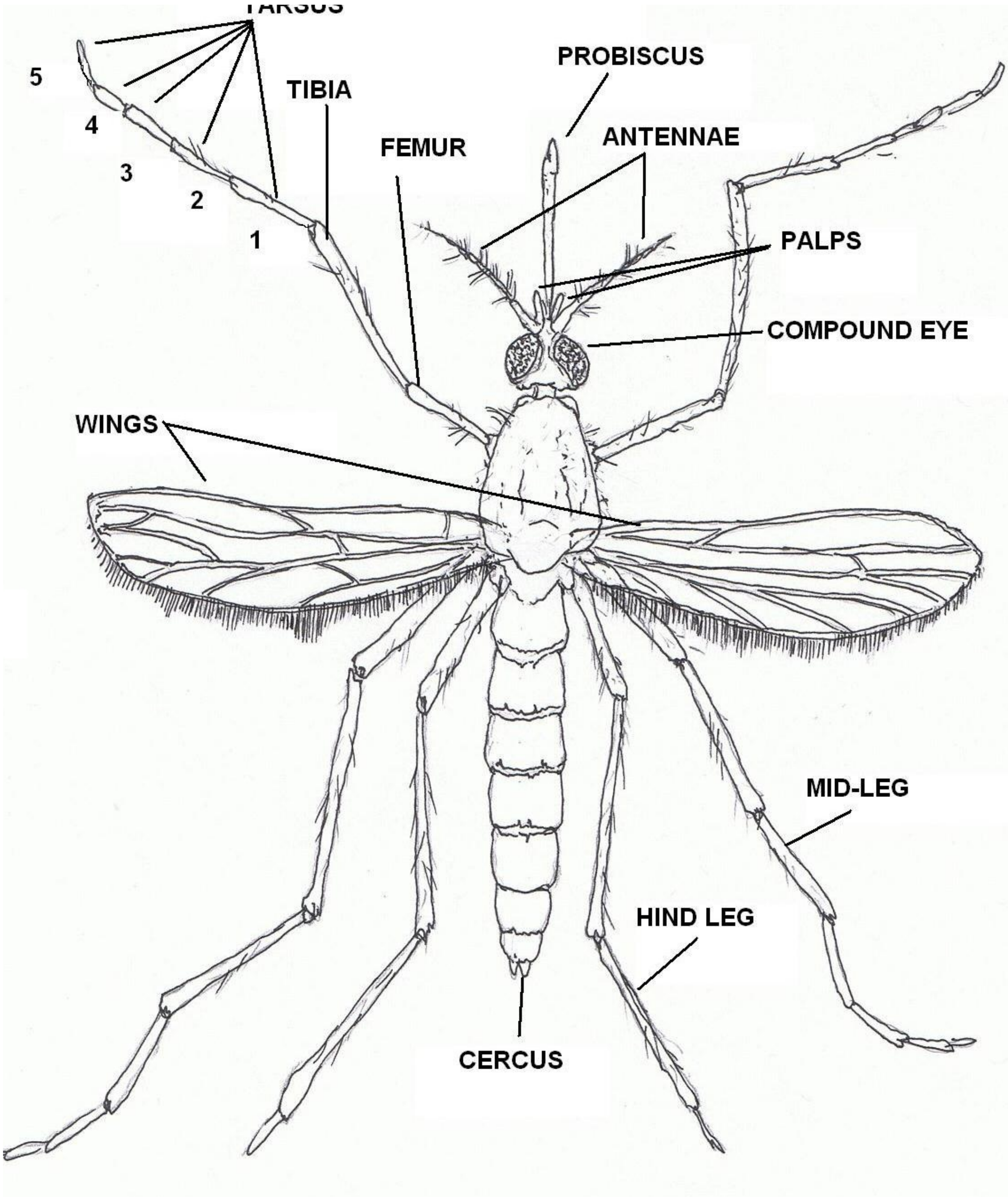
Genus Orthopodomyia 3 spp. signifera, alba

Genus Psorophora 15 spp. ciliata, columbiae, cyanescens, ferox, signipennis

Genus Toxorhynchites 2 subspecies

Genus Uranotaenia 3 spp. & subspecies
Sappharina

Genus Wyeomyia 4 spp. mitchellii

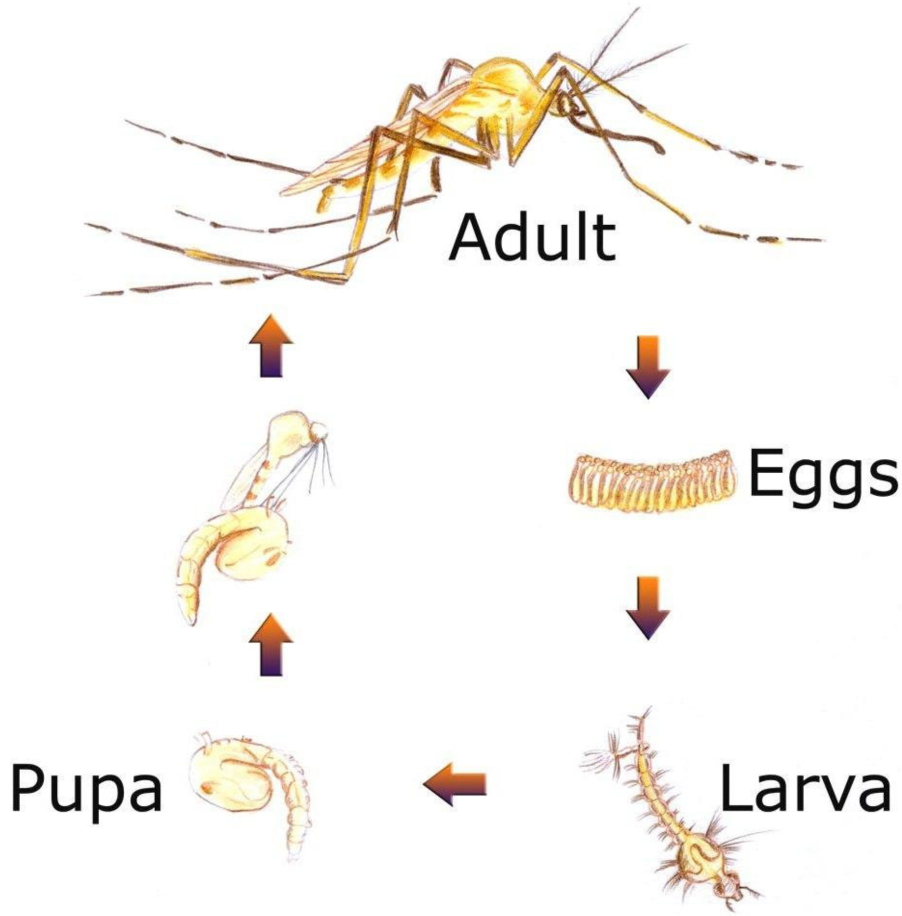


MOSQUITO ANATOMY DIAGRAM #2

Mosquito Life Cycle Sub-Section

The type of standing water in which the mosquito chooses to lay her eggs depends upon the species. The presence of beneficial predators such as fish and dragonfly nymphs in permanent ponds, lakes, and streams usually keep these bodies of water relatively free of mosquito larvae.

However, portions of marshes, swamps, clogged ditches, and temporary pools and puddles are all prolific mosquito breeding sites. Other sites in which some species lay their eggs include tree holes and containers such as old tires, buckets, toys, potted plant trays, and saucers and plastic covers or tarpaulins.



LIFE CYCLE DIAGRAM #1

Some of the most annoying and potentially dangerous mosquito species, such as the Asian tiger mosquito, come from these sites. The mosquito goes through four distinct stages during its life cycle:

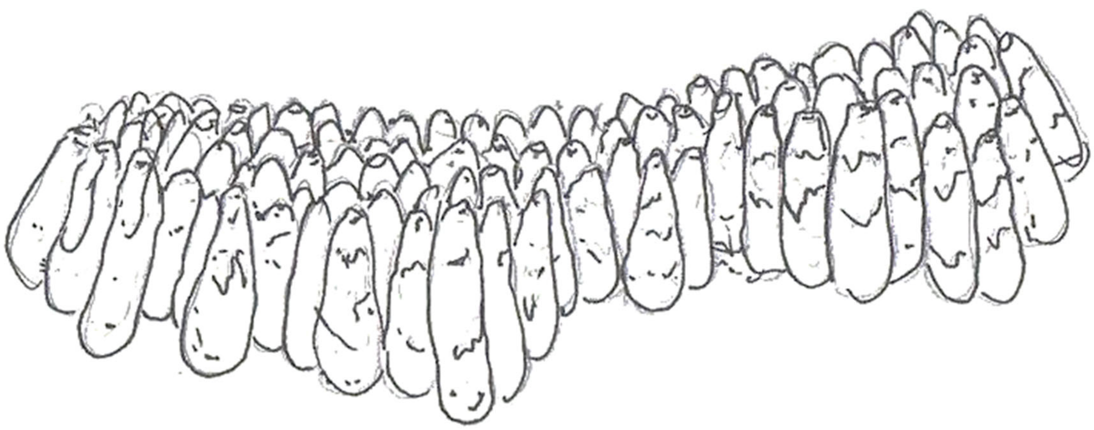
- **Egg:** hatches when exposed to water;
- **Larva** (plural. - larvae)**:** lives in the water; molts several times; most species surface to breathe air;
- **Pupa** (plural - pupae)**:** does not feed; stage just prior to emerging as adult;
- **Adult:** flies short time after emerging and after its body parts have hardened.

Wrigglers and Tumblers

The mosquitoes in the United States, all of which live in specific habitats, exhibit unique behaviors and bite different types of animals. Despite these differences, all mosquitoes share some common traits, such as a four-stage life cycle.

After the female mosquito obtains a blood meal (**male mosquitoes do not bite**), she lays her eggs directly on the surface of stagnant water, in a depression, or on the edge of a container where rainwater may collect and flood the eggs. The eggs hatch and a mosquito larva or "**wriggler**" emerges.

The larva lives in the water, feeds, and develops into the third stage of the life cycle called a pupa or "**tumbler**". The pupa also lives in the water, but no longer feeds. Finally, the mosquito emerges from the pupal case and the water as a fully developed adult female, ready to bite.



MOSQUITO EGGS (RAFT)

Mosquitoes may overwinter as eggs, fertilized adult females or larvae. Eggs, larvae, and pupae must have water to develop. Some female mosquitoes lay their eggs directly on the water surface.

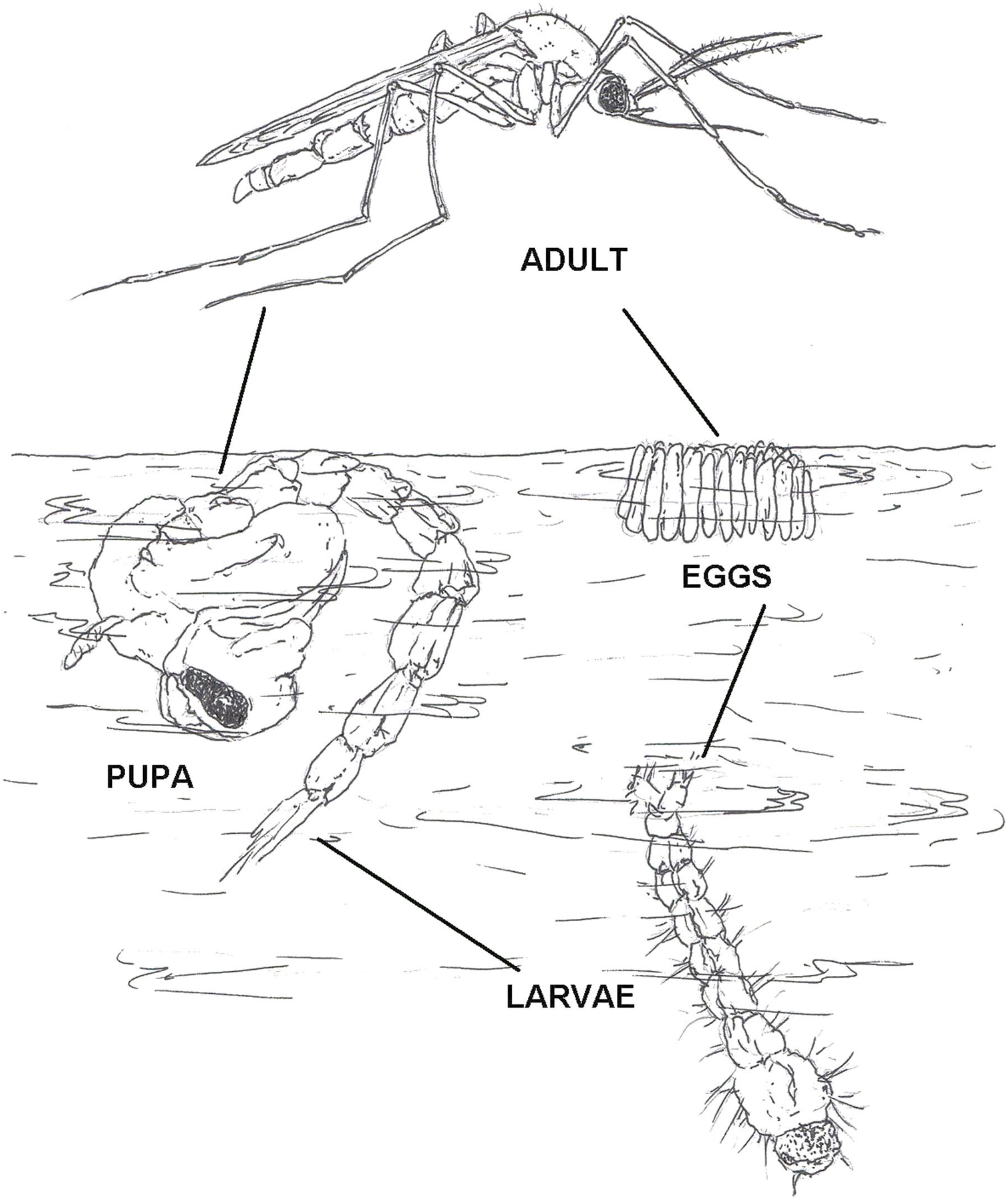
Others lay their eggs on substrates above the water line (flood pool mosquitoes); the eggs hatch upon flooding. In some cases, the eggs will remain viable for several years until further flooding occurs.

Mosquitoes belonging to the genus Culex lay their eggs in bunches or "*rafts*."

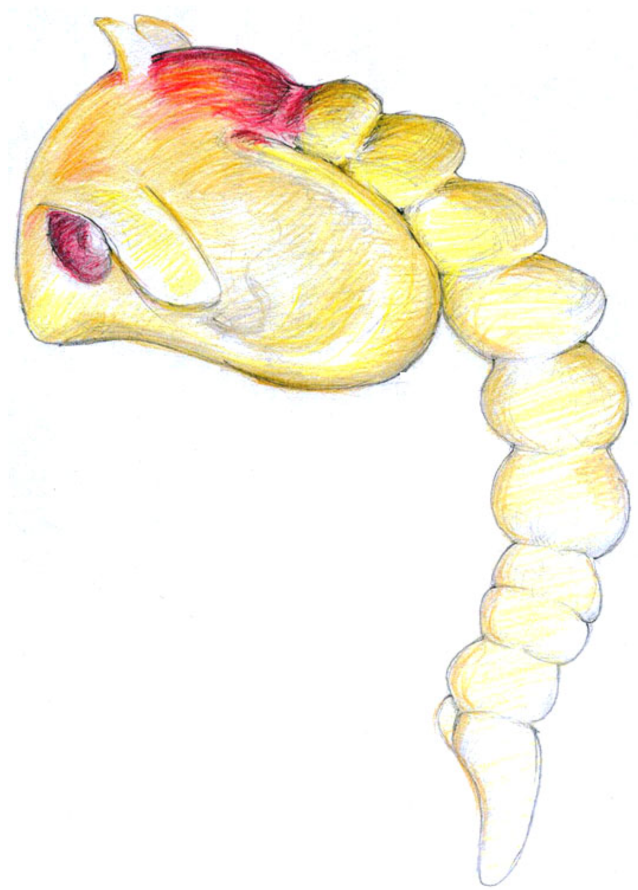
Each raft may contain up to 400 individual eggs. Larvae feed on bits of organic matter dispersed in the water, becoming full grown in about one week. The pupal stage lasts two to three days.

Female mosquitoes are ready to bite one to two days after adult emergence.
Male mosquitoes do not bite but feed on flower nectar or plant juices. Some mosquitoes have only one generation per year, whereas others may have four or more.

Adults may fly 5 to 10 miles, but usually rest in grass, shrubbery, or other foliage close to the water breeding area.



MOSQUITO LIFE CYCLE DIAGRAM #2



PUPA OF ANOPHELES FARAUTI

Mosquito Egg Classification

Mosquito eggs are generally cylindrical in shape, tapered at the top and rounded at the bottom. Each mosquito species prefers certain localities for depositing eggs. Some prefer very clean water, others slightly polluted water, while others thrive in extremely polluted water.

Oviposition Definition
An insect laying an egg or eggs with their ovipositor.

Ovipositor Definition
The ovipositor is a tube-like organ used by some animals for the laying of eggs. In insects, an ovipositor consists of a maximum of three pairs of appendages. The details and morphology of the ovipositor vary, but typically its form is adapted to functions such as transmitting the egg, preparing a place for it, and placing it properly. For insects, the organ is used merely to attach the egg to some surface, but for many parasitic species (primarily in wasps and other Hymenoptera), it is a piercing organ as well.

There are Five Distinct Types of Oviposition:
Single On Water: Anopheles and Toxorhynchites lay their eggs one at a time on the water surface.

Single in Soil: most Aedes and Psorophora lay their eggs one at a time on a moist substrate, such as mud and decomposing leaf litter.

Single On Cavity Walls: Wyeomyia, Orthopodomyia, and certain Aedes deposit eggs in tree holes, water-holding plants, or artificial containers. The eggs are placed just above the waterline.

Rafts On Water: Most Culex, Culiseta, Coquillettidia, and Uranotaenia lay eggs in masses, called rafts or boats, on the water surface.

On Plants: Mansonia eggs are deposited on the underside, and sometimes on top of the leaves of certain floating aquatic plants.

Weather
Mosquito development and population dynamics are closely tied to weather. When and how much rain is received, wind speed and direction, maximum and minimum temperatures, and the total amount of heat energy accumulated are all critical to mosquito development.

Water Source
The water (or lack thereof) in a habitat directly affects mosquito reproduction. All mosquitoes need standing water to complete their development. Factors such as when it first collects in sufficient quantities, how long it persists, quality, depth profile, vegetation and predator species (often lacking in artificial containers) and geographical distribution all affect mosquito development. Different species variously exploit nearly all combinations of these factors.

Mating most commonly occurs in twilight swarms within 2-3 days after females emerge. Most, but not all, females mate before they take blood.

Both sexes feed frequently on plant nectar; females take blood in order to obtain protein for egg development. A few species are autogenous, meaning they do not need a blood meal to produce eggs.

One Massachusetts species, the pitcher plant mosquito (Wy. smithii), never takes blood. Most females begin seeking hosts 2-4 days after emergence but some species (e.g., Cs. morsitans) may delay feeding for 2 weeks or more. Thus, the time period between adult emergence and the first egg laying (first gonotrophic cycle) is usually 7-10 days.

Subsequent host-feeding to egg-laying cycles in most temperate species require 4-6 days. Species that transmit disease (vectors) must feed at least twice, once to acquire the infection, and once to transmit it, unless the infection is acquired transovarially (into the egg while in the ovary) from their mother. This means that females must normally survive for 12-14 days in order to be a vector.

If the extrinsic incubation period of the pathogen/parasite in the mosquito is longer than the gonotrophic cycle, as is often the case, the survival time required for transmission is even longer. Most females do not survive beyond the first oviposition but a few individuals in all mosquito populations live a long time (i.e., several weeks). Exceptionally, overwintering adults live 5-7 months. Males generally survive for shorter periods than females and never overwinter.

Mosquito Habitat Sub-Section - Introduction

Mosquitoes can live in almost any environment, with the exception of extreme cold weather. They favor forests, marshes, tall grasses and weeds, and ground that is wet at least part of the year. Because they must have water in order to thrive, their habitats break down into two basic types:

Permanent water mosquitoes tend to lay their eggs in clumps, called rafts, of 50 to 300 on the surface of standing water at the edges of lakes and ponds and among the vegetation in swamps and marshes. Some species prefer clean water, while *Culex pipiens*, the northern house mosquito, prefers stagnant or polluted water.

Culex **and** ***Anopheles*** mosquitoes are among the most common permanent water mosquitoes. These mosquitoes are most active when the average temperature is above 70 degrees. Their eggs must stay in water in order to survive and usually will hatch within a couple of days, releasing larvae to begin the development process.
Many permanent water mosquitoes can also breed in containers that collect and hold water, such as wading pools, buckets or toys left outside.

Floodwater mosquitoes lay their eggs in moist soil. The eggs, as many as one million per acre, will dry out as the ground does, then hatch when rains saturate the ground and water levels begin to rise. Floodwater habitats include:

- Drainage **ditches** that fill during storms.
- **Woodland pools** created by melting snow, or spring and early summer rains.
- **Floodplains** along the banks of streams and rivers.
- Irrigated **pastures** and **fields**.
- **Meadows** and other soft ground where depressions form.

Common species include the *Aedes vexans*, also known as the inland floodwater mosquito. Mosquitoes that breed in floodwater habitats usually become a problem about seven to 10 days after a heavy rain, and subside in about a week or two.

Floodwater mosquitoes also breed in containers. *Aedes albopictus*, the Asian tiger mosquito, prefers the insides of old tires where dirty water collects, and *Aedes triseriatus* prefers treeholes that gather rainwater.

Stagnant Water

Eliminate standing water around the property to reduce the numbers of potential mosquito breeding sites. Ideally, this should be a community goal because most mosquitoes can fly long distances.
The types of modifications include:

- Removing old tires, cans, buckets, pots, and similar items that can trap rainwater.
- Position tarps and boat covers to allow rain runoff and limit ‘ponding.’
- Potted plants with water-capture bases should be drained or screening applied to the overflow vents.
- Turn plastic wading pools and wheelbarrows upside-down when not in use.
- Change birdbath water at least once a week.
- Keep swimming pools chlorinated and stock ornamental ponds with surface-feeding minnows.

- Rain gutters should be installed with sufficient slope to prevent the pooling of water; remove leaves and other obstructions from downspouts.

Running Water
Few mosquito species in the U.S. breed in running waters, such as streams. Larvae can be flushed out when stream volume increases, and to remain in the stream requires a large amount of energy. The tropical genus *Chagasia* and some *Anopheles* species are stream breeders. In addition, *Anopheles quadrimaculatus, Culex territans, and Uranotaenia sapphirina* have all been found in streams, although they prefer other habitats. Stream breeders will find vegetation along banks with which to anchor themselves or attempt to remain away from the main flow of the stream by seeking isolated eddies.

Chagasia is one of the three mosquito genera in the subfamily Anophelinae. The other two genera are *Anopheles* Meigen (nearly worldwide distribution) and *Bironella* Theobald (Australia only). The genus is found in the Neotropics. *Bironella* appears to be the sister taxon to the *Anopheles*, with *Chagasia* forming the outgroup in this subfamily. The species *Chagasia bathana* has eight chromosomes.

Anopheles is a genus of mosquitoes (Culicidae). Of about 484 recognized species, over 100 can transmit human malaria, but only 30–40 commonly transmit parasites of the genus *Plasmodium* that cause malaria, which affects humans in endemic areas. *Anopheles gambiae* is one of the best known, because of its predominant role in the transmission of the deadly species *Plasmodium falciparum*.

Transient Water
Transient water sources, such as flooded areas, snowpools, and ditches, are used as breeding grounds for mosquito species whose eggs can withstand desiccation, such as *Aedes* and *Psorophora*. Their life cycles require alternating periods of wet and dry. Other species, like an opportunistic *Culex,* might be able to pull off a single generation during an extended flooded period. Transient water generally shows water quality changes which result in various mosquito species using the same pool over a period of time.

Standing Water Mosquitoes
Permanent water group. Mosquito groups assigned to the permanent water group are Anopheles spp., Culex (Melanconium) spp., Cx. salinarius, Cx. territans, Coquillettidia spp. and Mansonia spp. As examples, the following permanent water habitat types and resident species are more or less typical of those found throughout the nation.

Freshwater Marsh
Mosquito species often found in freshwater marshes include An. walkeri, An. crucians, Psorophora columbiae, Cx. nigripalpus, Cx. salinarius, Cx. tarsalis, Cx. erraticus and Cx. peccator.

Lakes
Larvae may be found when many species of floating or emergent plants are present, but where vegetation occurs only in a narrow band along the lakeshore, larvae are confined to this littoral zone. Lake species include An. crucians, An. quadrimaculatus spp. complex, An. walkeri, Uranotaenia sappharina, Ur. lowii, Cx. salinarius, Cx. nigripalpus, Cx. erraticus, Cx. peccator, Cq. perturbans, Ma. dyari and Ma. titillans.

Ponds and Seepage Areas
There is no clear distinction between a pond and a lake except that ponds are generally smaller. Grassy woodland ponds or fluctuating ponds occupy shallow depressions and are filled by rainwater or surface run-off. They are usually of uniform depth, but the area they cover will vary, depending on rainfall.

Sinkhole ponds are usually quite deep and may be covered with vegetation or free of all except marginal plants. Both types of ponds may contain larvae of An. crucians, An. quadrimaculatus spp. complex, Culiseta inornata, Cs. melanura, Cx. nigripalpus, Cx. quinquefasciatus, Cx. restuans, Cx. salinarius, Cx. erraticus, Cx. peccator, Cx. pilosus, Cx. territans and Ochlerotatus canadensis. The seepage areas around hillsides and ponds or streams most often breed An. punctipennis, An. quadrimaculatus spp. complex, Oc. sticticus and Ps. ferox.

Springs
Mosquito breeding in springs is restricted to the quiet edges where vegetation affords cover for the larvae and there is little, if any, water movement. The only species recorded from are An. quadrimaculatus spp. complex and An. perplexens.

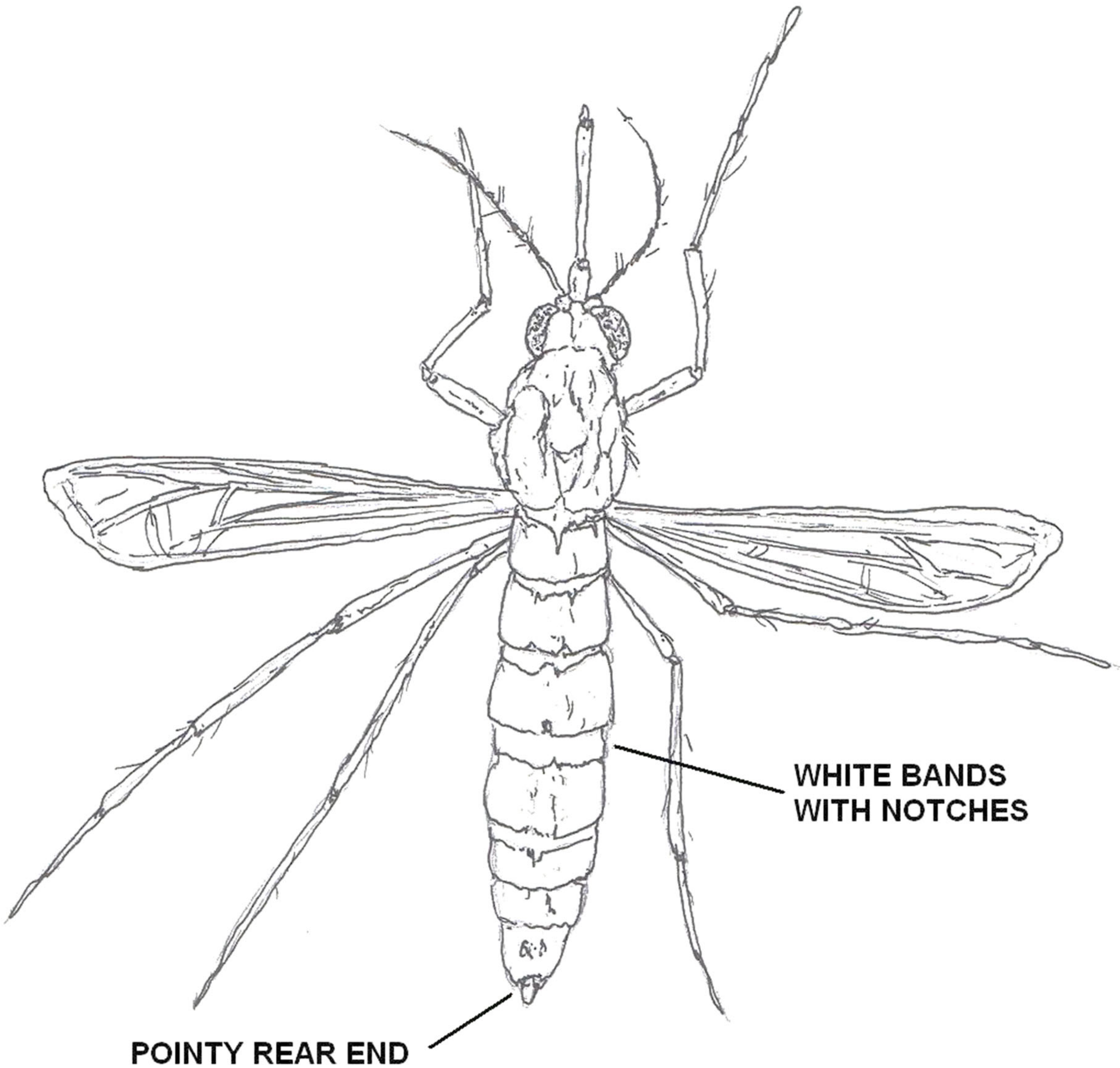
Swamps
Swamps differ from marshes principally in having dense cover from larger trees. The most common species of mosquito larvae found here are An. crucians, An. quadrimaculatus spp. complex, Cs. melanura, Oc. canadensis, Mansonia spp. and Cq. perturbans.

Transient Water Group
Mosquito groups assigned nationally to the transient water group are Cx. quinquefasciatus, Cx. tarsalis, Cx. restuans, Cs. inornata and Cs. melanura. As examples, the following specific habitat types and resident species are more or less typical of those found throughout the nation.

Salt or Brackish Water Ditches
The ditches adjacent to saltwater marshes contain many species of grasses and support a large mosquito fauna, including Oc. taeniorhynchus, Oc. sollicitans and An. bradleyi.

Borrow Pits and Canals
These man-made bodies of open water produce more mosquitoes as they silt-in and become overgrown with vegetation. They yield An. quadrimaculatus spp. complex, Cs. inornata, Ps. columbiae, Oc. canadensis, Cx. nigripa1pus, Cx. quinquefasciatus, Cx. restuans, Cx. salinarius, An. albimanus, Cq. perturbans and Mansonia spp.

Freshwater Drainage Ditches
In pastures, at the bottom of road shoulders, in old fields and in lowland groves, freshwater ditches will often yield the following species of mosquito larvae: Ps. columbiae, Cx. nigripalpus, Cx. pilosus, Cx. erraticus, Cx. quinquefasciatus, An. crucians, An. walkeri, Oc. atlanticus, U. sappharina, U. lowii, Ps. ciliata and Oc. sollicitans.



INLAND FLOODWATER MOSQUITO
(Aedes vexans)

Floodwater Mosquito Sub-Section

Floodwater Group

Mosquito groups assigned nationally to this floodwater group are Oc. sollicitans, Oc. taeniorhynchus, Oc. tormentor/atlanticus, Oc. thelcter, Oc. dorsalis, Oc. nigromaculis, Ae. vexans, Ps. ferox and Ps. columbiae. As examples, the following specific habitat types and resident species described are more or less typical of those found throughout the nation.

Mangrove Swamp

In the transitional zone from normal high tide to above all but the highest spring and storm tides, the heaviest mosquito breeding occurs. Plant and grass cover keep moisture conditions suitable for egg laying. Eggs are usually laid on sloping sides of potholes, ditches, sloughs, marsh edges or on the sides of small depressions, and sometimes over extensive, level, grass-covered areas. The eggs of some species require alternate flooding and drying before hatching. Species most often occurring are Oc. taeniorhynchus, Oc. sollicitans, An. atropos and Cx. nigripalpus.

Salt Marsh

Salt-tolerant herbaceous plants and typical salt grasses dominate this type of habitat. Extensive areas are often covered by a single plant species such as Distichlis spicata, Batis maritima or Salicornia perennis. It is in association with one of these plants or with black mangrove (Avicennia germinans) that breeding of Oc. taeniorhynchus and Oc. sollicitans occurs.

Rain and Floodwater Pools

These pools form the breeding place for a large number of species, especially Psorophora, Aedes and Ochlerotatus. The pools disappear in dry weather and support no true aquatic vegetation, though usually a layer of leaves and other detritus settles on the bottom. Mosquito species found in this habitat are Ps. johnstonii, Ps. pygnaea, Oc. atlanticus, Oc. bahamensis, Oc. dupreei, Oc. fulvus pallens, Oc. infirmatus, Oc. mitchellae, Oc. sticticus, Oc. tormentor, Ae. vexans, Ae. cinereus, Cx. atratus, Cx. pilosus and Cx. nigripalpus.

Artificial Container and Tree-hole Group

Mosquito groups assigned nationally to the artificial container and tree-hole group are Ae. aegypti, Oc. triseriatus, Oc. sierrensis, Ae. albopictus, Cx. quinquefasciatus, Toxorhynchites spp. and Orthopodomyia spp. As examples, the following specific habitat types and resident species described are more or less typical of those found throughout the nation.

Tree Holes

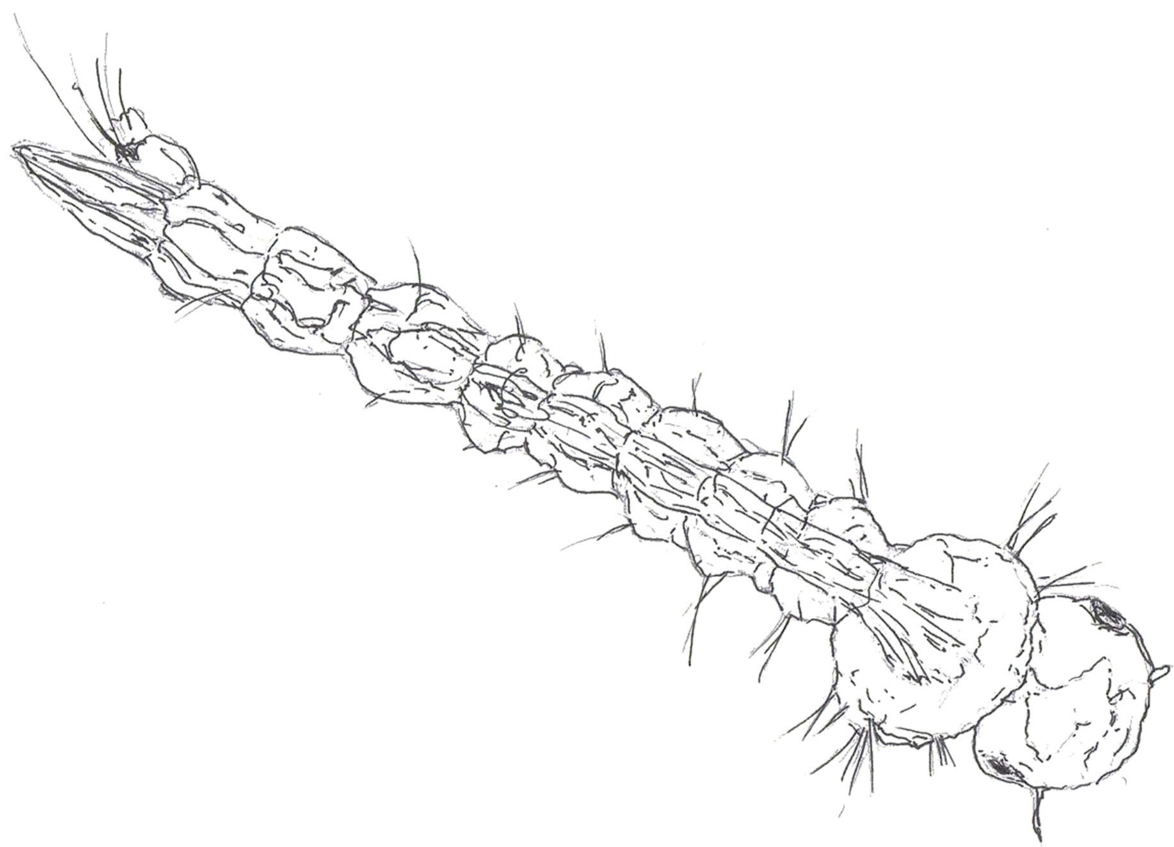
Tree holes or rot cavities support a rather extensive and unusual mosquito fauna, with many species breeding almost exclusively in this habitat. Resident species are An. barberi, Tx. rutilis, Tx. r. septentrionalis, Oc. triseriatus, Oc. hendersoni, Or. signifera, Or. alba, Oc. thibaulti and Ae. albopictus.

Crab Holes

Along the eastern coast the holes of the large land crab, Cardisonza guanhumi, serve as the larval habitat for Deinocerites cancer and Cx. opisthopus.

Artificial Containers
Several species breed in human-created situations around human dwellings. Tin cans, fish pools, cisterns, rain barrels, gutters and old tires, etc., containing water serve as excellent larval habitat. Species most often encountered are Ae. aegypti, Oc. triseriatus, Cx. quinquefasciatus, Cx. restuans, Cx. salinarius, Cx. nigripalpus and Ae. albopictus. That many species are found in multiple habitat types and some in very specialized habitats illustrates the complexity of the problem faced by control agencies. While habitat association with many species is quite specific, others thrive in a variety of situations. Thus, the detection of adults of these latter species in routine surveys does not provide an immediate indication of the related breeding site(s).

Permanent water - These waters (also known as semi-permanent) are present for extended periods of time and support characteristic aquatic vegetation. Cattail, rushes and sedges are typical freshwater swamp vegetation. Genera associated with permanent water are *Anopheles, Culex, Culiseta, Coquillettidia,* and *Uranotaenia*. Eggs of these species are not desiccant-resistant and must be laid directly on the water. *Aedes* adults will oviposit near the edge of the swamp or within tussocks of vegetation, requiring later flooding to inundate the eggs for hatching. As with transient waters, there is a seasonal change in the vegetation, water quality, and mosquito species present. Permanent waters include:



MOSQUITO LARVAE

Mosquito Introduction Section Post Quiz

Integrated Pest Management -Introduction
1. Both CDC and EPA recognize a legitimate and compelling need for the use of biological interventions, under certain circumstances, to control adult mosquitoes.
True or False

Short Range Attractants
2. Light colors capture heat and make most people more attractive to mosquitoes. Dark colors refract heat and are generally less attractive to mosquitoes.
True or False

How Long Do Mosquitoes Live?
3. Mosquitoes that hibernate in the adult stage live for 6-8 months, but spend most of that time in a state of torpor.
True or False

Canine Heartworm
4. Dogs are quite susceptible to canine heartworm, a nematode that can be transmitted by certain mosquitoes.
True or False

World-Wide Distribution
5. Anopheles are _______________of numerous animal pathogens, including species of malaria protozoa that do not affect humans.

Anophelinae (Genus subfamily)
6. Adult anophelines are easily recognized by their appearance. Most species stand with the body inclined at an angle of 30-45° to the surface and have ______________on the veins of the wings.

Tipulidae (Crane Fly Family)
7. Numerous other common names have been applied to the crane fly, many of them more or less regional, including mosquito hawk, mosquito wolf, mosquito eater (or skeeter eater), gallinipper, and gollywhopper.
True or False

Wrigglers and Tumblers
8. After the female mosquito obtains a blood meal, she lays her eggs directly on the surface of stagnant water, in a depression, or on the edge of a container where rainwater may collect and flood the eggs. The eggs hatch and a mosquito pupa or "tumbler" emerges.
True or False

9. The larva lives in the water, feeds, and develops into the third stage of the life cycle called a larva or "wriggler". The pupa also lives in the water, but no longer feeds.
True or False

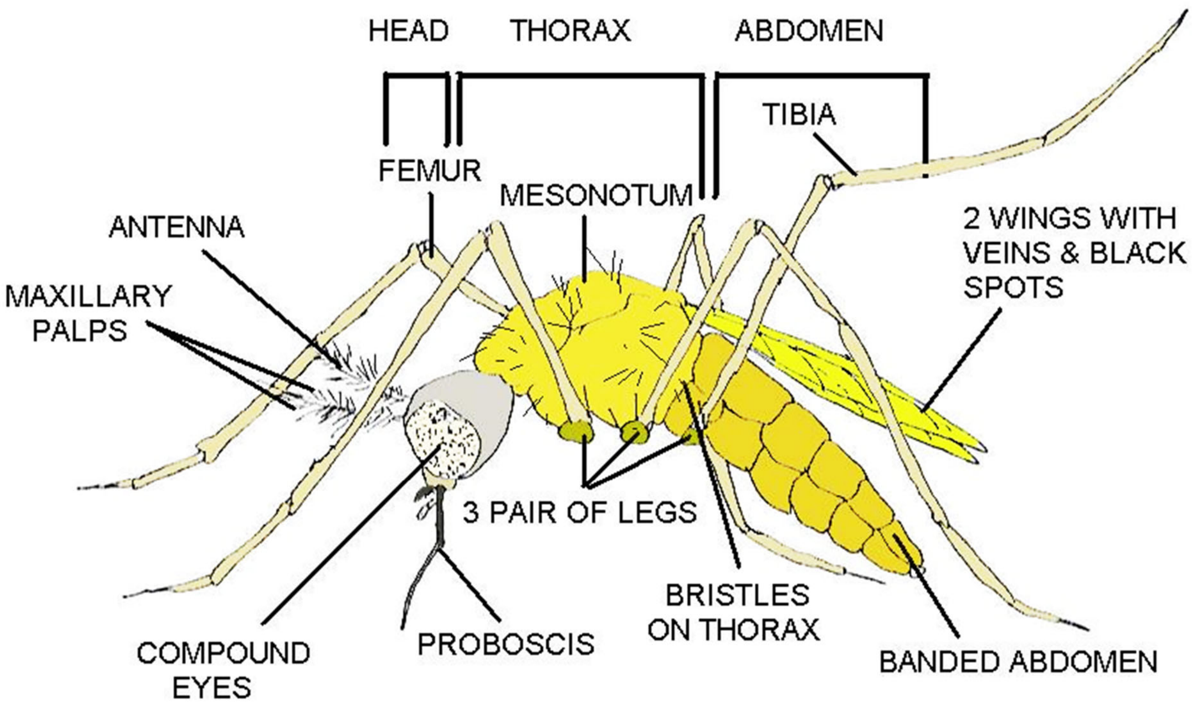
10. Finally, the mosquito emerges from the pupal case and the water as a fully developed adult female, ready to bite.
True or False

Post Quiz Answers
1. False, 2. False, 3. True, 4. True, 5. Vectors, 6. Dark and pale spots of scales, 7. True, 8. False, 9. False, 10. True

Topic 5 – Mosquito Identification Section

Section Focus: You will learn to properly identify mosquito species. At the end of this section, you will be able to understand and describe specific mosquitoes and their habitats. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: This training section has been prepared for use as an identification to mosquitoes. It is critical that we master identifying your target in that we do not destroy other wildlife during treatment operations.

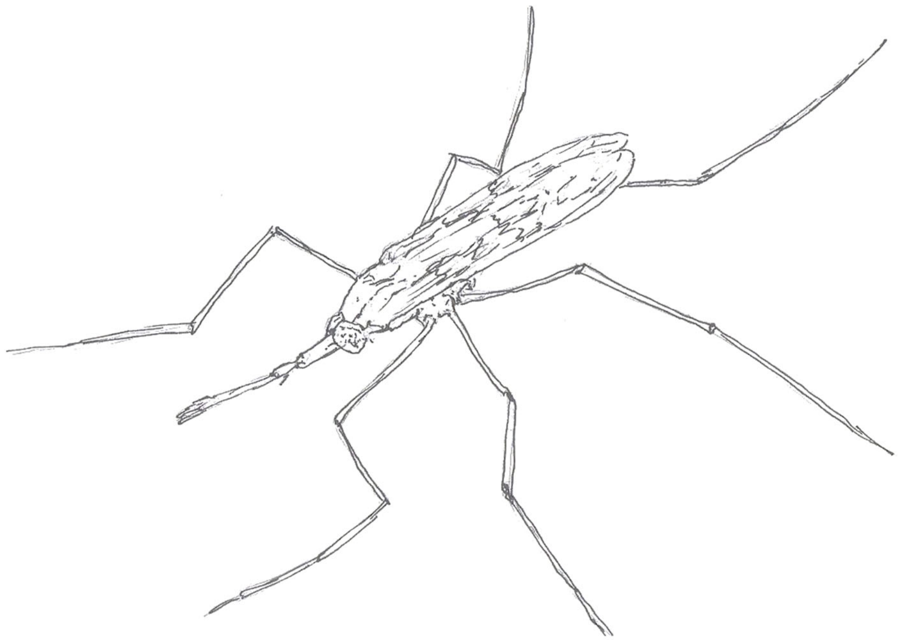


ADULT FEMAL MOSQUITO
(Anopheles Spp.)

Anopheles spp.

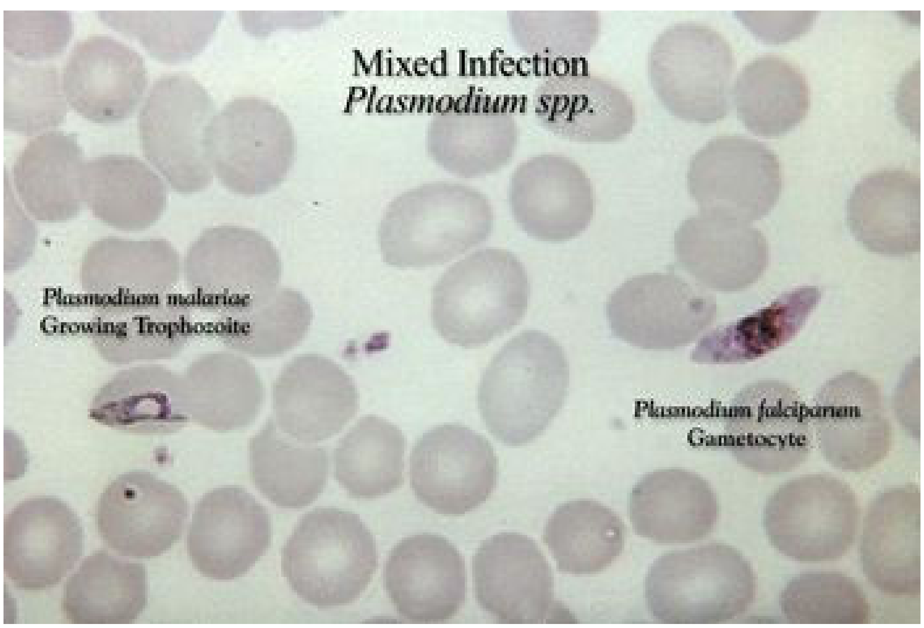
(Life; Kingdom: Metazoa; Phylum Arthropoda; Class: Hexapoda; Order: Diptera; Suborder: Nematocera; Family: Culicidae; Subfamily: Anophelinae)

Of the insects that serve as vectors for parasitic diseases, this genus is arguably the most important. Of the approximately 422 species of *Anopheles*, about two dozen serve as vectors for malaria (*Plasmodium* spp.) in humans. Mosquitoes also serve as the vector for canine heart worm (*Dirofilaria immitis*).



WOODLAND MALARIA MOSQUITO
(Anopheles punctipennis)

There are about 422 species of *Anopheles* worldwide, many of them sibling species that can only be identified using genetic techniques. Of these, about 70 are vectors of the protozoan *Plasmodium* that causes malaria, but only about 40 are important. Malaria infects 300-500 million people and kills 1.5-2.7 million people each year, making it by far the most serious of the diseases spread by insects.



SCIENTIFIC NAME	COMMON NAME	HABITAT	MEDICAL IMPORTANACE
Aedes albopictus	Asian Tiger Mosquito	Lucky bamboo plants in nurseries and man-made containers	Potential vector for dengue fever, WNV, and other encephalitis viruses
Aedes aegypti	Yellow Fever Mosquito	Urban environment indoors and outdoors in containers that can hold water.	Yellow fever, chikungunya and dengue fever
Aedes notoscriptus	Australian Backyard Mosquito	Urban environment in outdoor containers that can hold water.	Canine heartworm vector
Anopheles franciscanus	none	Shallow sunlit pools with algae	Not known to carry disease in California
Anopheles hermsi	Western Malaria *Mosquito*	Clear pools with matted algae	Malaria vector
Culex erythrothorax	Tule Mosquito	Ponds, lakes, wildlife refuges, and marshes with tules and cattails	Potential vector for WNV
Culex stigmatosoma	Banded Foul Water Mosquito	Polluted water (e.g., industrial and agricultural wastes); prefers to bite birds	Secondary SLE vector
Culex quinquefasciatus	Southern House Mosquito	Polluted water (e.g.,septic tanks, dairy drains, catch basins, and underground storm drains)	Vector of WNV; secondary for SLE and WEE

Culex tarsalis	Western encephalitis Mosquito	Agricultural, commercial, man-made or natural sources	Principal SLE, WEE, and WNV vector
Culex thriambus	none	Foothill riparian habitats, in sunlit pools, along streams and other water courses	Potential vector for WNV
Culex restuans	none	Found in foul water	Potential vector for WNV
Culiseta incidens *Culiseta inornata* *Culiseta particeps*	Cool Weather Mosquitoes	Fresh and brackish waters and containers	Not known to carry disease in California
Ochlerotatus sierrensis	Western treehole mosquito	Treeholes (particularly oak), tires, and containers	Canine heartworm vector
Ochlerotatus washinoi	Woodland pond Mosquito	Occurs in floodwater habitats	Not known to carry disease in California

6 NOTORIOUS MOSQUITOS

	CULEX TARSALIS	CULEX PIPIENS / QUINQUEFASCIATUS	AEDES AEGYPTI	AEDES ALBOPICTUS	AEDES VEXANS	ANOPHELES
						
FOUND	RURAL AREAS THROUGHOUT NORTH AMERICA	URBAN AREAS OF THE TROPICS, SUBTROPICS THROUGHOUT THE WORLD	TROPICS & SUBTROPICS, BUT CLIMATE CHANGE IS CAUSING TRAVEL NORTH	NATIVE TO TROPICAL ASIA, BUT HAS BEEN INTRODUCED TO EUROPE, AND PARTS OF THE AMERICAS & AFRICA	ONE OF THE MOST COMMON SPECIS IN THE U.S. & EUROPE, IT CAN ALSO BE FOUND IN PARTS OF ASIA AND NORTHERN AFRICA	EVERYWHERE EXCEPT ANTARTICA
DISEASES	ENCEPHALITIS	WEST NILE AND SOMETIMES ENCEPHALITIS	ZIKA, YELLOW FEVER, DENGUE AND CHIKUNGUNYA	ZIKA, DENGUE, CHIKUNGUNYA YELLOW FEVER & ENCEPHALITIS	IT RARELY TRANSMITS DISEASE TO HUMANS, BUT LAB TESTS HAVE FOUND IT IS CAPABLE OF WEST NILE & ENCEPHALITIS	ABOUT 30 - 40 DIFFERENT SPECIES, ALL TRANSMIT MALARIA AND SOME CAN SPREAD ENCEPHALITIS
BITES	AT DUSK AND AFTER DARK	AT DUSK AND AFTER DARK	DURING THE DAY	DURING THE DAY	LATE AFTERNOON / NIGHT, BUT THEY ARE USUALLY KILLED SEASONALLY BY AUTUMN FROST	DURING DUSK, DAWN & NIGHT

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AEDES AEGYPT		STILT MOSQUITO
		
DAYTIME (Can sting at night)	**HABITS**	NOCTURNAL
DARK (With white stripes)	**COLOR**	BROWN
ALMOST CLEAN WATER (Little organic matter)	**BREEDING SITES**	POLLUTED WATER (Contains lots of organic matter)
4 - 6 mm	**SIZES**	4 - 10 mm
SEVERAL (In multiple locations)	**EGGS**	TOGETHER (In clusters)

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MOSQUITO COMPARISON

Mosquito Identification Sub-Section
Alphabetical Common Name Order

Asian Mosquito AKA Asian Tiger Mosquito
(*Aedes albopictus*)

Aedes albopictus

Aedes albopictus, an Asian mosquito, probably was introduced into Hawaii late in the last century. Until its discovery in Houston, Texas, in August 1985, this species was unknown in the New World. It is believed to be established in 866 counties in 26 states in the continental U.S.

The northernmost established infestation in the U.S. is Chicago, Illinois, although an infestation was found in Minnesota in 1997. In the Northeast, it has been reported from New Cumberland (York County), Pennsylvania and, in 1995, from Cumberland, Salem, and Monmouth counties in New Jersey. It has been found as far south as Cameron County, Texas, and Monroe County, Florida. In the West, it occurs in Del Rio (Val Verde County) and Lubbock (Lubbock County), Texas, and Omaha (Douglas County), Nebraska.

Limited focal infestations in at least three northern states, Indiana, Minnesota, and Ohio, apparently have been eliminated through persistent control efforts by state and local agencies, perhaps coupled with severe winter temperatures. Nonetheless, other areas in Indiana and Ohio continue to be infested. During 1994, Georgia became the first state to document Ae. albopictus in all counties of the state and has since been joined by Florida, South Carolina, and Tennessee.

Aedes albopictus is a maintenance (occasionally epidemic) vector of dengue viruses in parts of Asia and is a competent vector of several other viruses under experimental conditions. Since the discovery of Ae. albopictus in the United States, five arboviruses (eastern equine encephalomyelitis, keystone, Tensaw, Cache Valley, and Potosi) have been isolated from this mosquito. Of these five viruses, only eastern equine encephalomyelitis and Cache Valley viruses are known to cause disease in humans.

Aedes albopictus was independently introduced into Brazil in 1986 and is now widespread in seven Brazilian states. In May, 1993, it was found to be established in the Dominican Republic, the first established infestation by this species of a Caribbean Island. In September, 1993, Ae. albopictus was also discovered in two border cities in Coahuila State, Mexico.

Subsequent studies indicate that areas of Tamaulipas and Nuevo Leon are also infested. In 1995, the Guatemalan Ministry of Health and Japanese entomologists in Guatemala reported finding Ae. albopictus at three sites in the Department of Izabal on the Atlantic seacoast. Also in 1995, infestations were reported from Cuba and Bolivia, but the current status of those infestations is uncertain. In 1996, infestations were reported from El Salvador and Colombia. In 1997, this species was reported from the Cayman Islands. In 1991, Ae. albopictus was found in Delta and Benue states in Nigeria. During 1994, additional infestations were found in Imo, Anambra, and Enugu states. In Europe, Ae. albopictus has been present in Albania since at least 1979.

More recently, infestations have been found in Italy (Genoa in 1990 and Padua in 1991) with a suggestion that the Padua introduction could have resulted from tire imports from the United States. Eighty-five percent of the imported tires came from a single source in Atlanta, Georgia; the remaining 15% came from the Netherlands. Ae. albopictus has rapidly become the most important pest mosquito species in areas of northern Italy and is now present in nine of Italy's 21 political regions, i.e., Veneto, Lombardy, Emilia Romagna, Liguria, Tuscany, Lazio, Piedmont, Campania, and Sardinia. Aedes albopictus is also expanding its distribution in the Pacific. Infestations were discovered in Palau in 1988 and in Yap in 1995. This mosquito was first discovered in Fiji on the island of Viti Levu in 1988, and has since spread to the next two largest islands in the group. Ae. albopictus has been found in port cities of both the north and south islands of New Zealand, and in Queensland and the Northern Territory of Australia, but apparently, has not become established.

Aedes albopictus is a potential vector of epidemic dengue. It is unclear what effect the presence of this species might have on transmission dynamics in the Americas. Ae. albopictus may also affect the disease potential for yellow fever in Brazil by bridging the ecological niche between jungle and urban transmission cycles. DVBID maintains a national database (under construction for web posting) on the distribution of Ae. albopictus, with particular emphasis on detecting its spread in areas in which La Crosse and eastern equine encephalitis viruses are enzootic. DVBID also studies the biology and vectorial capacity of Ae. albopictus and is the primary source of information about its distribution, vector competence, biology, and control in the Americas.

The Asian tiger mosquito, Aedes albopictus (Skuse), was first documented in the United States in Texas in 1985 (Sprenger and Wuithiranyagool 1986). A year later, the Asian tiger mosquito was found in Florida at a tire dump site near Jacksonville (O'Meara 1997).
Since that time, this species has spread rapidly throughout the eastern states, including all of Florida's 67 counties (O'Meara 1997).

The arrival of Aedes albopictus has been correlated with the decline in the abundance and distribution of the yellow fever mosquito, Aedes aegypti (Linnaeus). There are a number of possible explanations for the competitive exclusion of Ae. aegypti by Ae. albopictus. The decline is likely due to a combination of (a) sterility of offspring from interspecific matings; (b) reduced fitness of Ae. aegypti from parasites brought in with Ae. albopictus and; (c) superiority of Ae. albopictus in larval resource competition (Lounibos 2002). The distribution of Ae. aegypti currently is limited to the southeastern quadrant of the U.S., and small areas in New York and Arizona (Darsie and Ward 2005).

Aedes albopictus is a competent vector of many viruses including dengue fever (CDC 2001) and Eastern equine encephalitis virus (Mitchell et al. 1992). Its life cycle is closely associated with human habitat, and it breeds in containers with standing water, often tires or other containers. It is a daytime feeder and can be found in shady areas where it rests in shrubs near the ground (Koehler and Castner 1997). Aedes albopictus feeding peaks in the early morning and late afternoon; it is an opportunistic and aggressive biter with a wide host range including man, domestic and wild animals (Hawley 1988).

Bold Black Shiny Scales
Adult Aedes albopictus are easily recognized by the bold black shiny scales and distinct silver white scales on the palpus and tarsi (Hawley 1988). The scutum (back) is black with a distinguishing white stripe down the center beginning at the dorsal surface of the head and continuing along the thorax. It is a medium-sized mosquito (approximately 2.0 to 10.0 mm, males are on average 20% smaller than females). Differences in morphology between male and female include the antennae of the male are plumous and mouthparts are modified for nectar feeding.

The abdominal tergites are covered in dark scales. Legs are black with white basal scales on each tarsal segment. The abdomen narrows into a point characteristic of the genus Aedes. Field identification is very easy because of these distinct features.

After entering the United States almost twenty years ago, Aedes albopictus has spread throughout much of the eastern states. The mosquito was most likely transported along highways and other major roadways in shipments of used tires imported from other countries for retreading. On January 1988, the U.S. Public Health Service required all used tires entering the U.S. from known endemic countries be dry, clean and treated with fumigants (Moore and Mitchell 1997). Surveillance for Ae. albopictus was initiated in 1986 and this species continues to be monitored by public health agencies (Morbidity and Mortality Weekly Report 1989).

Tolerance to Pesticides
Management of adult populations is more complicated than for other species due to insecticide tolerance to malathion, temephos and bediocarb (Morbidity and Mortality Weekly Report 1987). In many suburban areas, complaints to health departments are more frequently due to Ae. albopictus than in former years when Ae. aegypti was the most commonly reported nuisance mosquito (Morbidity and Mortality Weekly Report 1989). Source reduction is an effective way for people in the community to manage the populations of many mosquitoes, especially container breeding species such as the Asian tiger. The removal of mosquito breeding habitat can be an effective method for mosquito control (Dame and Fasulo 2003).
Eliminate any standing water on the property, change pet watering dishes, overflow dishes for potted plants, and bird bath water frequently. Do not allow water to accumulate in tires, flower pots, buckets, rain barrels, gutters etc. Use personal protection to avoid mosquito bites. Long sleeves and insect repellent such as DEET will reduce exposure to bites.

The Asian tiger mosquito is a day biter with feeding peaks early morning and late afternoon, so by limiting outdoor activities during crepuscular periods (dawn and dusk) when mosquitoes are generally most active, bites can be avoided.

Life Cycle

Female tiger mosquitoes are the sex of most concern to humans because, as in the case for all mosquitoes, only females bite. The reason for the particular lust for blood by the female mosquitoes is the drive to reproduce. Blood is a rich source of protein which nourishes mosquito egg development and has since the age of the dinosaurs. Blood is not a food to sustain mosquito physiology aside from ovarian development. Carbohydrates from flower nectar fuel the daily activity of male and female mosquitoes.

Female tiger mosquitoes seek water-holding containers in which to lay their eggs. Any container from a tire casing to a tree hole is a possible breeding site, but this mosquito has preferences. Outdoor containers are greatly preferred over indoor containers and outdoor containers in the shade are preferred over those in full sunlight. Containers holding dark stained water high in organic content are preferred over containers holding clear, clean water.

Eggs are deposited along the sides of a container, just above the water surface. The rate of hatching success increases if the eggs remain unflooded for a few days after being laid and the eggs can remain viable for long periods before flooding, such as during prolonged droughts.

The eggs are stimulated to hatch when the water level in the container rises and floods the eggs, provided the water temperature is above 60¤F. If colder water temperatures prevail, the eggs will not hatch, but can remain viable for long periods (overwinter) until warmer temperatures return. After hatching, mosquito larvae live in the water for one to several weeks, depending on water temperature and the amount of food present.

Immature mosquitoes go through four growth stages and molt their skins four times as their size increases. The last immature stage is known as the pupa. In the pupal stage, changes occur allowing the transformation from an aquatic larva to a terrestrial, free-flying adult mosquito. During the summer, the immature life stage typically lasts five to ten days.

Mating takes place shortly after adults emerge from breeding sites. Females mate only once in their lifetime. Sperm is stored in the females' bodies and they can lay fertile eggs several times during a life span. Two to three days after emergence, female mosquitoes take their first blood meal. Tiger mosquitoes rest, fly and bite close to the ground. They bite in the daytime, rarely at night.

Early morning and late afternoon are peak biting times. Tiger mosquitoes are strongly attracted to bite humans, but will feed on cats, dogs and other mammals, as well as birds active on the ground. They will bite any exposed skin surface, but prefer to feed around the ankles and knees. They bite outdoors and indoors, but are usually found outside. On average, tiger mosquitoes ingest 2 - 6 milliliters of blood per bite.

Egg Laying

Female tiger mosquitoes lay 40 to 150 eggs after obtaining a blood meal. The cycle of blood feeding and egg laying will continue throughout the mosquito's life span. Egg laying occurs about once per week. The maximum number of eggs laid per lifetime by female tiger mosquitoes is about 300.

Adult tiger mosquitoes live from a few days to several weeks, largely depending on weather conditions. Hot, dry weather reduces life expectancy. Regardless of life span, adult tiger mosquitoes seldom move far from the containers in which they were born. Most adults will be found within a few hundred yards of the breeding container.

In many states, tiger mosquito eggs are present year round. Larvae are present from April through October. Adult tiger mosquitoes are found May through October. The period of peak population is June through September.

Tiger mosquitoes are known to transmit the causative agent of dog heartworm disease. In New Orleans, the tiger mosquito is a principal vector of dog heartworm. In Polk County, Florida, field populations of tiger mosquitoes were found to carry eastern equine encephalitis virus in 1991. In Asia, this species is a vector of dengue fever and Japanese encephalitis. Laboratory studies have found the tiger mosquito to be an efficient vector of many viral disease agents including yellow fever, West Nile virus, St. Louis encephalitis and LaCrosse encephalitis.

Monitoring Population (Surveillance)
Adult tiger mosquitoes are not readily attracted to standard light traps which are used for determining the population level of most Maryland mosquito species. Traps using carbon dioxide as an attractant are useful for monitoring population trends of adult tigers. The most efficient and widely used surveillance technique in Maryland is the landing rate count. Landing rate counts are taken by inspectors using themselves as "bait" to attract female tiger mosquitoes. As they land on the inspector to bite, mosquitoes are identified, killed and tallied. Counts are taken for two to five minutes, during which the inspector tallies the total number of mosquitoes landing. Inspectors wear dark colored clothing and, of course, are not allowed to use mosquito repellent. Trap collections and landing rate counts are taken between the hours of sunrise to sunset when tiger mosquitoes are most active.

Larval surveillance is carried out by visual inspection of containers and by dipping. The larvae are easily disturbed by vibration or shadows passing over their surface, and either event will send the larvae to the bottom of the container where they are difficult to find.

Tiger Mosquito Control
Control of tiger mosquitoes by conventional methods in the United States has proven to be difficult. The impact of several predators and parasites as biological control agents of larvae has been investigated. In general, these agents have been found to play a small role in regulating the number of mosquitoes but not a significant impact.

The most promising predators of tiger mosquito larvae are mosquito fish (Gambusia spp.) and cannibal mosquitoes (Toxorhynchitus spp.). Fish are very effective when stocked in cisterns, water barrels and ornamental ponds, but many of the breeding sites of tiger mosquitoes are so small and cryptic as to make the use of fish of limited value. Cannibal mosquitoes are predaceous as larvae on a wide range of aquatic organisms, including mosquito larvae. These mosquitoes are also container breeders and would seem to be an ideal candidate species as a biocontrol agent of tiger mosquitoes.

Tiger mosquito larvae are susceptible to the toxic spores produced by the bacteria Bacillus thuringiensis israelensis (Bti). The insect juvenile hormone mimic methoprene does not kill tiger mosquito larvae, but prevents maturation to adult mosquitoes.

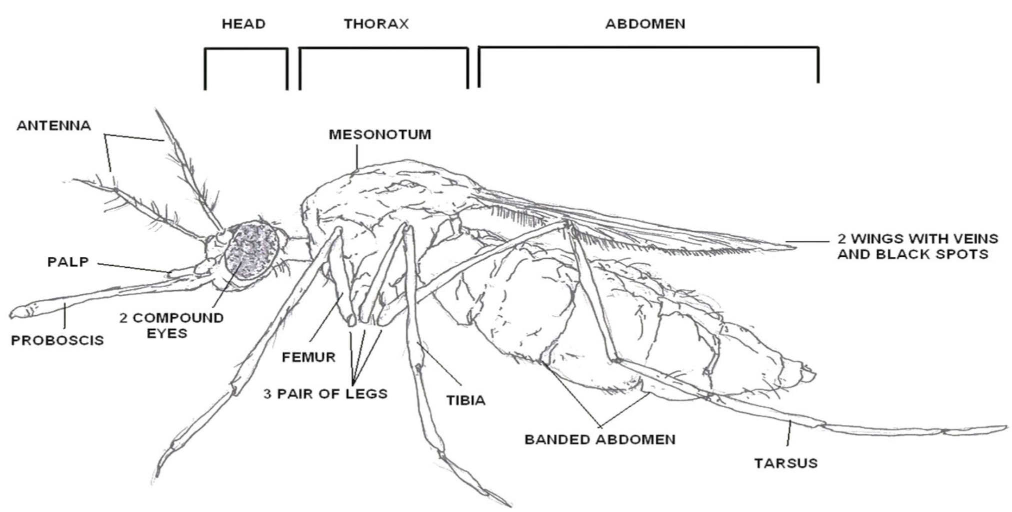
The problem of controlling tiger mosquitoes with Bti and methoprene is how to deliver the products to the breeding sites. Due to the large number and cryptic location of breeding sites, application of larvicides is labor intensive and beyond the resources of public agency mosquito control programs.

Insecticides
Control of adult tiger mosquitoes by various insecticides can be effective, providing temporary relief from biting annoyance and can reduce the risk of disease transmission. Spraying is most effective when done during early evening (one hour before to two hours after sunset) and early morning (two hours before to one hour after sunrise).

Those mosquitoes killed by spraying can be replaced by newly emerged adults because of the rapid breeding cycle of the tiger mosquito. In communities infested by moderate to high populations of tiger mosquitoes, adult mosquito control spraying may be necessary once per week, or more frequently, from June through September.

The most effective method of controlling tiger mosquitoes is reducing or eliminating the containers which are the source of the problem. Draining or removal of water holding containers, even on a localized basis, will produce remarkable long-term reductions in mosquito annoyance. The list of breeding sites is extensive and includes any water holding containers, but the primary sites in residential areas include clogged rain gutters, tires, buckets, cans, bottles, boats, flower pots, bird baths, outdoor statuary, ornamental pools, plastic or canvas tarpaulins, children's toys, rain barrels, and pet food and water dishes.

The elimination of the breeding containers for tiger mosquitoes is largely the responsibility of the individual to conduct thorough and repeated efforts to remove or drain all such containers on his/her property. On an individual basis, this is not a large task. The original cleanup of containers on a residential area should take no more than a few hours and periodic maintenance to keep each yard free of breeding containers will require a minimal time investment by individual residents.



ANOPHELES MOSQUITO

Black Salt Marsh Mosquito *(Aedes taeniorhynchus)*

Aggressive biting contributes to its notoriety as a pest insect

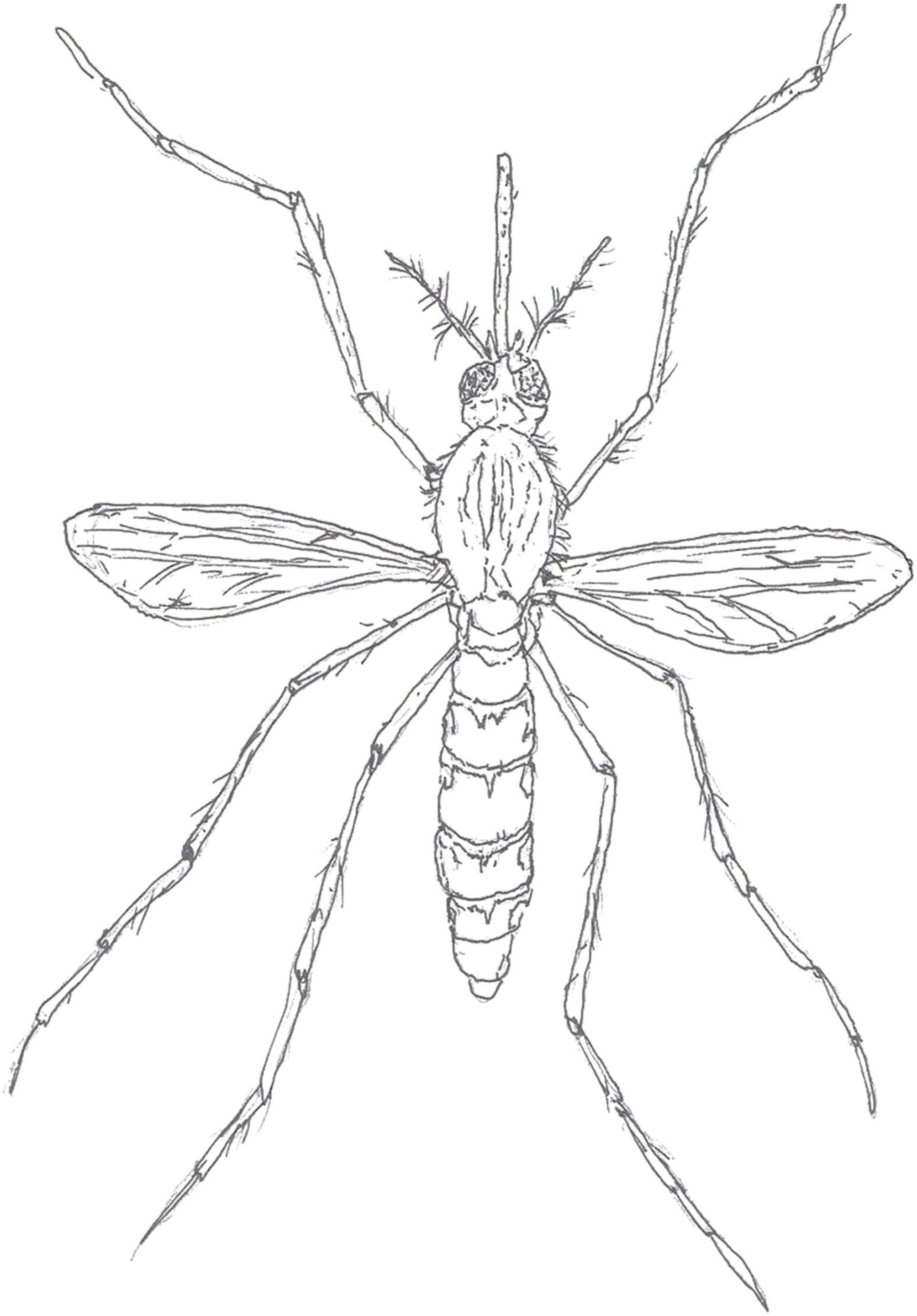
The black salt marsh mosquito, *Aedes taeniorhynchus* (Wiedemann), is very common in the eastern coastal areas of the Americas, and is responsible for a large part of mosquito insecticide applications in Florida (Connelly and Carlson 2009, Koehler and Castner 2008). Although it is not a primary vector of major concern, it can transmit pathogens to humans and other animals. Its characteristic emergence in large numbers after rains and flooding events as well as its aggressive biting contribute to its notoriety as a pest insect.

The black salt marsh mosquito is considered a nuisance in Florida, parts of Mexico and now in California. It is sheltered from large-scale mosquito control as part of the Everglades National Park conservation program to preserve their delicate ecosystem (Day et al. 2004).

Like other true flies, *Aedes taeniorhynchus* has four distinct life stages: adult, egg, larva, and pupa (Borror and White 1970).

Adults: Like other flies (order Diptera), *Aedes taeniorhynchus* possess a pair of wings for flight and a pair of knobby halteres for directional perception and stability. Like other mosquitoes, black salt marsh mosquitoes have long, narrow wings with scales along the wing veins. Female mosquitoes of the subfamily Culicinae, like *Aedes taeniorhynchus,* also possess palps shorter than the proboscis. The mouthparts of mosquitoes are made up of a pair of stylets for piercing and a feeding tube for sucking. Collectively these mouth parts are referred to as a proboscis.

Male and female mosquitoes can be distinguished by their antennae. Males have feather-like or plumose antennae, while females have antennae with only a few hairs (Borror and White 1970). Bands of white scales found in characteristic body locations are useful markings for identification of this species. The white banding on the basal section of abdominal segments, typical of *Aedes* mosquitoes, as well as the white coloration on the tip of the palps and a ring of white scales on the middle of the proboscis, can be used to distinguish *Aedes taeniorhynchus* from similar species (Darsie and Morris 2003).



AEDES AEGYPTI

Black-Tailed Mosquito (*Culiseta melanura)*

Primarily take their blood meals from birds.

The beautiful black-tailed mosquito, *Culiseta melanura* (Coquillett, 1902), belongs to the family Culicidae. This species of mosquito is considered unusual because it overwinters as larvae while most mosquito species overwinter as either adults or eggs. *Culiseta melanura* is important because of its role in the transmission cycle of eastern equine encephalitis virus and potentially West Nile virus (Cupp et al. 2003, Molaei and Andreadis 2006).

Larvae: The larvae of most mosquito species have a siphon (breathing tube) for acquiring air from just above the surface of water while submerged. *Culiseta melanura* larvae have long siphons that can be distinguished from those of other mosquito larvae by the presence of two or three setae (hairs) located at the very base of their siphons (Darsie and Ward 2005).

Other identifying characteristics of *Culiseta melanura* larvae are a row of 8-14 setae running horizontally down the siphon and a single row of bar-like comb scales located on the eighth section of the abdomen (Darsie and Ward 2005, Crans 2010).

Pupae: Mosquito pupae are comma-shaped because the head and thorax are fused and enlarged and the segmented abdomen attached to this region hangs down below it (Jackman and Olson 2002) and have two horn-like breathing structures. *Culiseta* pupae can usually be distinguished from *Aedes* pupae by the placement of small hairs on the ninth segment of their abdomens (Barr 1963).

More specifically, a *Culiseta melanura* pupa can be recognized by the long hairs present on the second segment of its abdomen (Barr 1963). A second apical seta on the paddle distinguishes *Culiseta melanura* from other *Culiseta* pupae (Darsie et al. 1962).

Adults: *Culiseta melanura* is a medium-sized mosquito that resembles *Culex* species because of its bluntly rounded abdominal tip (King et al. 1960). This species can easily be recognized by its unusually long, curved dark-scaled proboscis which is a cluster of tube-shaped mouth parts used for feeding (King et al. 1960). Palpi are also dark in color and short. The occiput of the head is covered with narrow yellow scales and dorsally divided by dark scales that stand upright. The lateral part of the head has a patch of white scales while the antennal tori are brown, turning darker on the interior. Its thorax is covered in scales that are mostly bronze-brown and golden-brown (Carpenter and LaCasse 1955).

Pre-spiracular setae are present, post-spiracular setae absent. The pleura is speckled with dirty-white scales. The tergites of the abdomen are covered with dark-brown to black scales with a bronze to slightly purple reflection with small yellow-white patches on the lateral bases. Some segments may appear to have narrow yellow-white light bands. The ventral abdomen is covered in dirty white or yellow with sporadic dark-colored scales. The legs are primarily dark-scaled except at the posterior, which is pale. (Carpenter and LaCasse 1955). Wings are approximately 4.0 mm in length and cross veins 3-4 and 4-5 on vein 4 are set apart from each other at a length larger than the largest cross vein. The scales on cross veins are absent. Longitudinal veins are covered in dark, broad strap-like scales. The base of the subcosta on the underside of the wing has a cluster of dark setae (Carpenter and LaCasse 1955).

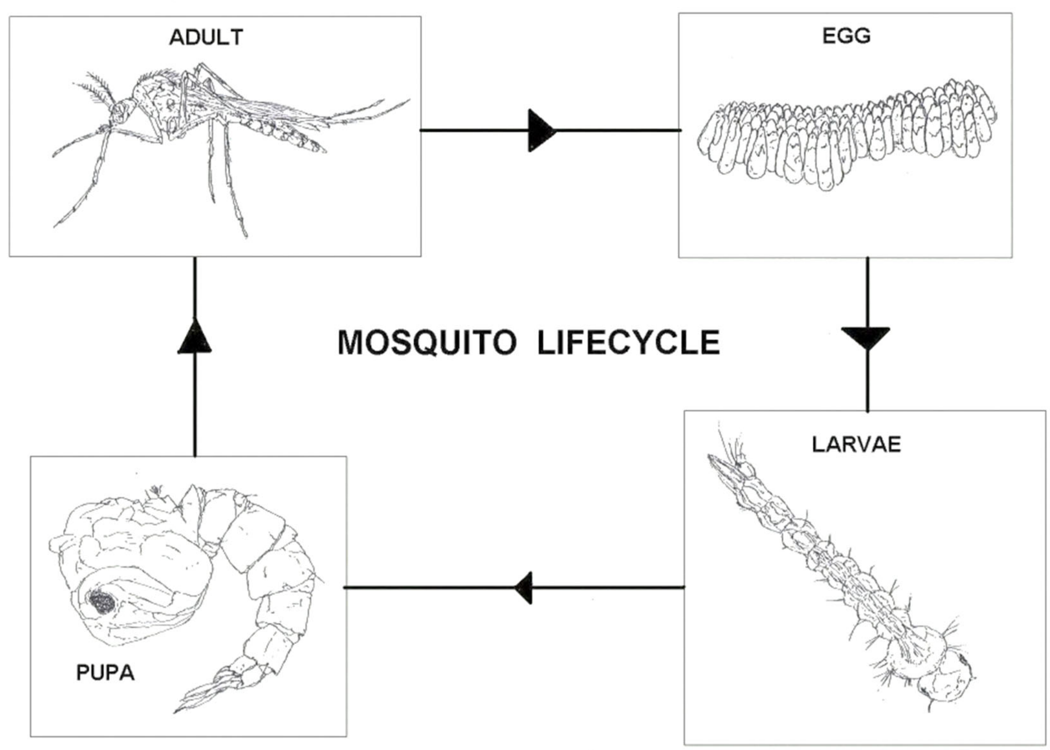


DIAGRAM #3

Life Cycle

Culiseta melanura has multiple generations per year in the southern part of its range (Horsfall 1955), but Mahmood and Crans (1998) suggest that the species has only two generations per year in the northeastern portion of its range due to cold temperatures. Adult females favor laying their eggs in habitats with acidic water and are normally captured near water with a pH of 5.0 or lower (Crans 2010). Females lay their eggs on the surface of water in underground crypts such as around the base of cypress, white cedar, or red maple trees or in rotted out stumps (Carpenter and LaCasse 1955).

Larvae typically hatch within two days (Mattingly 1972). *Culiseta melanura* larvae are filter feeders and use their brush-like mouthparts to feed on decaying plant matter suspended in the water (Jackman and Olson 2002). Like most mosquito larvae, *Culiseta melanura* larvae mature in 4 to 10 days and then enter the pupal stage (Jackman and Olson 2002).

If temperatures are cold larvae do not pupate and instead burrow into the bottom sediment and overwinter as 3rd and 4th instar larvae depending upon how late in the season eggs hatch. Those that hatch in the late summer to early fall overwinter as 4th instar larvae while those that are oviposited after the water temperatures have cooled overwinter as 2nd or 3rd instar larvae. Late instar larvae will pupate in April and emerge as adults by early May with several generations occurring each summer with two major peaks in adult populations approximately one month apart (Crans and Mahmood 1998, Crans 2004, Hickman and Brown 2003).

The pupae remain in the water and do not eat. Temperature affects the length of the pupal stage which may last several days (Jackman and Olson 2002).

Adult males feed only on nectar and other plant juices. Females also feed on nectar and plant juices but also require blood meals as a source of protein in order to mature their eggs (Jackman and Olson 2002). Adult female *Culiseta melanura* primarily take blood meals from birds such as the American robin, wood thrush, and gray catbird (Molaei and Andreadis 2006). Blood-feeding is at its highest during the first two hours after sunset but continues at a lower, constant level until sunrise (Hickman and Brown 2003).

A few studies have shown that *Culiseta melanura* females take a low percentage of their blood meals from mammalian hosts, specifically, white-tailed deer, raccoons, domesticated cats, and humans (Molaei and Andreadis 2006, Molaei et al. 2006). Adult female mosquitoes typically live for about a week to a month, while males usually die shortly after mating (Jackman and Olson 2002).

Medical and Veterinary Importance

Because adult female *Culiseta melanura* primarily take their blood meals from birds, they are responsible for transmitting eastern equine encephalitis virus between birds (Crans 2010). Humans, horses, and other mammals become infected with eastern equine encephalitis virus when other mosquito species besides *Culiseta melanura*, such as *Aedes*, *Coquillettidia*, and *Culex* species take blood meals first from infected birds and then later take blood meals from mammals, transferring the virus to these hosts (CDC 2009). Molaei et al. (2006), showed that a small percentage of *Culiseta melanura*'s blood meals were from mammals, which suggests that *Culiseta melanura* can be involved in the transmission of eastern equine encephalitis virus directly to mammals.

Eastern equine encephalitis virus can cause severe disease in human, horses, dogs, and some bird species (Zacks and Paessler 2010). Fever, headache, vomiting, seizures and coma may occur in humans infected with eastern equine encephalitis virus (Zacks and Paessler 2010). Neuroinvasive disease due to eastern equine encephalitis virus causes fatality in up to 70% of human cases, and over 200 human cases due to eastern equine encephalitis virus have been recorded in the U.S. since 1964 (CDC 2009, Zacks and Paessler 2010). It is particularly pathogenic in children, the elderly, and those with compromised immune systems although even healthy individuals can exhibit severe symptoms.

A vaccine is available for horses, but not humans. Over 70 horses positive for eastern equine encephalitis virus are typically reported each year in the state of Florida alone, and eastern equine encephalitis virus can be fatal in up to 90% of unvaccinated horses (Bronson and Holt 2010, Zacks and Paessler 2010). Humans and equines are dead-end hosts for eastern equine encephalitis virus, meaning mosquitoes do not acquire the virus from them.

Eastern equine encephalitis virus was detected in mosquitoes one hour after feeding on infected blood, which shows that this virus is highly virulent. Eastern equine encephalitis virus can affect the reproductive fitness of *Culiseta melanura.* Laboratory experiments showed a reduction in the number of surviving larvae from infected females although the infected females oviposited more eggs than uninfected females. Female mosquitoes infected with eastern equine encephalitis virus also had shorter life spans than uninfected mosquitoes (Scott and Lorenze 1998).

Culiseta melanura is not considered to be an important vector of West Nile virus to humans. However, West Nile virus has been isolated from this mosquito species in many studies (Andreadis et al. 2001, Apperson et al. 2004, Godsey et al. 2005, Molaei and Andreadis 2006). Therefore, it is likely that *Culiseta melanura* may transmit West Nile virus between birds that then serve as part of the mechanism sustaining West Nile virus in a region (Godsey et al. 2005). For more information on West Nile virus, see the UF/IFAS publication West Nile Virus.

Management

Because *Culiseta melanura* is not a major nuisance to humans it is not usually targeted for mosquito control. Efforts to reduce *Culiseta melanura* mosquito populations are usually made upon the appearance of eastern equine encephalitis virus seropositive sentinels in an area (Morris 1990). Large *Culiseta melanura* populations can be mitigated through aerial applications of insecticide (Morris 1990).

Less effective ground-based adulticiding techniques may be used to control mosquitoes where aerial applications are not possible (Morris 1990). Applying larvicide to larval habitats may control larvae but reaching larval habitats can be difficult. Larval habitat reduction can be employed in an integrated pest management program.

Because *Culiseta melanura* larval habitats are in swamps, typically protected by environmental laws, habitat manipulation is not possible. For this reason, control of this species is difficult. However, unlike mosquito species that spend a portion of their life in temporary water environments, fish that feed on mosquito larvae can be used with some success to control *Culiseta melanura* (Rusmisel et al. 1999).

Cattail Mosquito (*Coquillettidia perturbans*)
AKA Salt and Pepper Mosquito

Seek humans for blood meals in shady places where adult mosquitoes are resting during the day.

Coquillettidia perturbans can travel several miles. Therefore, a more widespread survey of fresh water sources containing cattails, sedges, aquatic grasses, or arrowhead may have to be done. The eggs and larvae of this mosquito are usually found in the detritus material at the base of the aquatic plants. A mosquito dipper or siphon can be used to collect the larvae. However, the water may have to be placed in a pan containing clean water for accurate viewing and counting.

Because aquatic plants can, at times, produce heavily vegetated stands, the use of conventional mosquito management techniques may be ineffective. Predator fish are usually not effective because of the dense vegetation. Monomolecular oils do not work because the immature mosquitoes are located below the water surface. Bti may be effective if the product is applied directly to the infested areas. This may be difficult and labor intensive if the aquatic vegetation is dense. Eradication or maintenance level control of the aquatic plants is the best method of managing these mosquitoes.

This species is rather large, speckled brown and pale colored and has characteristic pale bands at the lower thirds of the hind leg segments. They are aggressive biters and readily enter homes. Larvae are unusually slow to develop and spend the entire development through pupa underwater. They are found attached to stalks of vegetation and do not need to rise to the surface to breath.

Larval habitat: Cattails marshes and in thick growth at edges of ponds, lakes and ditches
Biting time: Day and dusk
Preferred host: Mammals, including humans
Flight range: 1-5 miles from breeding site
Proboscis: dark, sprinkled with white scales basally and with broad median ring of pale scales.

Palpi: about one fifth as long as proboscis, dark-scaled, lightly speckled with pale scales.

Head: Occiput with pale-golden lanceolate scales and dark erect forked scales, a few pale forked scales on anterior part. Tori light brown on outer surface, darker and with a patch of grayish-white scales on inner surface.

Thorax: Integument of scutum mottled dark brown and black; scutum clothed with dark brown lanceolate scales intermixed with pale-golden lanceolate scales. The golden scales are more numerous anteriorly, laterally and on the pre-scutellar space. Scutellum with pale-golden scales and brown setae on the lobes. Pleura with patches of grayish-white scales. Spiracular and post-spiracular bristles absent.

Abdomen: First tergite dark-scaled; remaining tergites dark-scaled, with white or pale-yellow basolateral patches and occasionally with narrow basal segmental bands of pale scales. Venter with intermixed dark and pale scales, the pale scales more numerous on the basal part of the sternites. 8th segment bluntly rounded. 8th tergite without short stout spines.

Legs: Femora dark, speckled with pale scales, the apices almost entirely dark-scaled. Hind femur with narrow sub-apical, more or less distinct ring of pale scales. Posterior surface of middle and hind femora predominantly pale-scaled except near apices.

Front and middle tibiae dark-scaled, speckled with white, narrowly ringed with white scales at apices; hind tibia dark-scaled, speckled with white, ringed with white scales at outer third and at apex. 1st tarsal segment of all legs with narrow white ring basally and a broader white ring a little beyond middle; remaining tarsal segments each with basal half white apical half dark.

Wings: Length about 4.0 mm, scales broad, mixed dark and white.

Egg Rafts
The eggs are laid on the surface of water in areas of heavy emergent vegetation, after hatching the larvae attach themselves with their modified siphon to the roots or submerged stems of plants where they remain throughout development until they are ready to emerge as adults. They overwinter as larvae ...adults emerge in Spring and Summer.

They bite during night but will bite in shade if disturbed. They are strong fliers (1 to 5 miles) and are important pest in areas near shallow with emerged aquatic vegetation. They are attracted to light traps. They can transmit Eastern Equine Encephalitis.

Breeding Habitat
The first step in identifying the breeding habitat was to determine where to check for breeding. Knowing that Cq. perturbans is always found associated with the roots and stems of emergent vegetation surrounding bogs, ponds, lakes, etc., all possible breeding sites were selected and inspected.

These sites were selected with the use of topographic maps and aerial photographs of the area. Once all possible areas were identified, each of the areas was surveyed, both by ground and air, for the presence of emergent vegetation.

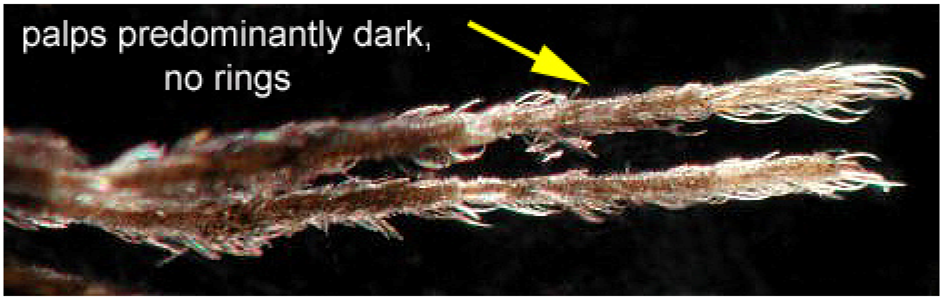
Common Malaria Mosquito (*Anopheles quadrimaculatus*)

Anopheles sp.
Another example of *Anopheles* sp.

Anopheles quadrimaculatus Say is historically the most important vector of malaria in the eastern United States. Malaria was a serious plague in the United States for centuries until its final eradication in the 1950s (Rutledge et al. 2005). Despite the ostensible eradication, there are occasional cases of autochthonous (local) transmission in the U.S. vectored by An. quadrimaculatus in the east and Anopheles freeborni in the west (CDC 2005).

In addition to being a vector An. quadrimaculatus can also be a pest species (O'Malley 1992). This species has recently been recognized as a complex of five sibling species (Reinert et al. 1997) and is commonly referred to as An. quadrimaculatus (sensu lato) when in a collection or identified in the field. The preferred hosts are large mammals including humans.

Distribution
Anopheles quadrimaculatus mosquitoes are primarily seen in eastern North America. They are found in the eastern United States, the southern range of Canada, and parts of Mexico south to Vera Cruz. The greatest abundance occurs in the southeastern U.S. (Carpenter et al. 1946, Carpenter and LaCasse 1955).



Mosquito Egg Classification
Mosquito eggs are generally cylindrical in shape, tapered at the top and rounded at the bottom. Each mosquito species prefers certain localities for depositing eggs. Some prefer very clean water, others slightly polluted water, while others thrive in extremely polluted water.

There are five distinct types of oviposition:
Single On Water: Anopheles and Toxorhynchites lay their eggs one at a time on the water surface.

Single in Soil: most Aedes and Psorophora lay their eggs one at a time on a moist substrate, such as mud and decomposing leaf litter.

Single On Cavity Walls: Wyeomyia, Orthopodomyia, and certain Aedes deposit eggs in tree holes, water-holding plants, or artificial containers. The eggs are placed just above the waterline.

Rafts On Water: Most Culex, Culiseta, Coquillettidia, and Uranotaenia lay eggs in masses, called rafts or boats, on the water surface.

On Plants: Mansonia eggs are deposited on the underside, and sometimes on top, of the leaves of certain floating aquatic plants.

Cool Weather Mosquito (*Culiseta incidens*)

Attacks large mammals and humans at night.

Culiseta is a genus of mosquitoes. Most *Culiseta* species are cold-adapted, and only occur in warmer climates during the colder parts of the year or at higher elevations where temperatures are lower. Species found in Southern California are larger than most mosquitoes species, specifically *Cs. inornata*, *Cs. particeps*, and *Cs. incidens*.

These species are found throughout the year in Southern California and feed on several vertebrate species, such as birds, livestock, rodents, reptiles, and humans.

The larvae of most species are found bogs, marshes, ponds, streams, ditches, and rock pools, but an African species occurs in tree holes ("phytotelmata"), a common eastern Palaearctic species occurs in water wells and rock pools, and several Australian species occur under ground. Little is known about the blood-feeding habits of females. Most species feed on birds and mammals, but a few feed on reptiles.

The cool-weather mosquito is a large species that seeks to bite large mammals and humans at night. It travels up to five miles from the shaded, clear water sources in which this species develops. Eggs are laid in rafts on the water surface. *C. incidens* is found throughout California, and is active in fall, winter, and spring.

Cs. inornata

Eastern Treehole Mosquito (*Aedes triseriatus*)

Small mammals are the preferred meal for the females.

EASTERN TREE-HOLE MOSQUITO

Aedes triseriatus is a treehole mosquito, breeding in the wild in holes left in trees when a branch breaks off and/or insect damage causes a part of the tree to rot out. Within the shaded forest it is a ready biter but it does not venture far from its breeding areas. Because it's larval habitat is widely dispersed (and often well above the height that a person could reasonably be expected to reach), larval control is not possible. Fortunately, because it stays within the woods, control targeting Ae. triseriatus is rarely necessary. Adult mosquitoes are small, fragile insects with slender bodies; one pair of narrow wings (tiny scales are attached to wing veins); and three pairs of long, slender legs. They vary in length from 3/16 to 1/2 inch. Mosquitoes have an elongate "beak" or piercing proboscis. Eggs are elongate, usually about 1/40-inch-long, and dark brown to black near hatching. Larvae or "wigglers" are filter feeders that move with an S-shaped motion. Larvae undergo four growth stages called instars before they molt into the pupa or "tumbler" stage. Pupae are comma-shaped and nonfeeding and appear to tumble through the water when disturbed.

Overwinter

Aedes triseriatus overwinter as eggs in the larval habitat; hatching occurs in early spring and development to the adult stage takes about 3 months. The first biting adults appear in late June. Larval populations are often crowded and asynchronous so some emergence continues until early August. A second generation of larvae has been observed, especially in tires, where water is usually warmer and development is faster. However, it is doubtful that many adults from this generation are successful at this latitude. This mammal-feeding, diurnal species does not normally disperse far from its sylvan larval habitats. Biting adults are particularly active in the late afternoon, pre-twilight period (i.e., 4-7 PM).

Tire Removal
If Ae. triseriatus stayed in the trees, it would be a minor pest, but it has become well adapted to breeding in tires, particularly where they are shaded. As a result, Ae. triseriatus can be a locally important pest wherever rimless tires are stored. Tire removal, and the prevention of illegal tire dumping along wooded roads, is an important part of mosquito control.

Vexans Mosquito
Aedes vexans. Aedes vexans is the most ubiquitous floodwater mosquito in North America and is the predominant summer re-flood mosquito. Aedes vexans is found in lake and river flood plains, shrub swamps, flooded meadows, and shallow grassy depressions associated with open habitats such as roadside ditches, pastures, golf courses and athletic fields. It will also breed in woodland pools and shallow cattail marshes, such as those that develop in some retention ponds. The first Ae. vexans are normally not on the wing before mid-June. Populations of Ae. vexans are unpredictable because they depend entirely on the frequency and spacing of major rains. Rainfall of 1 inch many produce some Ae. vexans but it usually requires 3" of rain within a short period of time (several days) to produce a large brood.

Larval Broods
Larval broods of Ae. vexans have been observed as late as mid-September. It is not always clear whether such late season broods result from the delayed and staggered hatching of eggs that are a year or more old or from the hatching of non-diapausing eggs laid earlier the same season. Brust and Costello (1967) and Horsfall et al (1973) have shown that many species such as Ae. vexans lay some eggs that will hatch without cold conditioning. Sequential hatching of eggs is also well documented in five reflood Aedes species (i.e., canadensis, cinereus, sticticus, trivittatus, and vexans). Larval development is rapid, 4-6 days, and the pupal stage lasts for about 2 days. Hence, the window for effective larval/pupal control is narrow. Moreover, a large number of scattered pools all need to be treated within the same brief time span following major rains.

Control efforts suffer from the same difficulties as described for Ae. canadensis, as Ae. vexans will often breed in mid-summer in the same pools used by Ae. canadensis in the spring.

Where possible, the best approach is to prevent mosquitoes from breeding by eliminating or modifying breeding sites. This can be accomplished best by eliminating containers which are capable of holding water. Where breeding sites exist in standing or slow-moving water, corrective action to permanently eliminate them by such means as filling, pumping, ditching or draining is recommended. Close coordination with your local mosquito abatement district and environmental regulatory authorities is recommended. An important consideration in the practice of mosquito control is the advisability, whenever possible, to target control operations against immature populations. These stages are usually concentrated, relatively immobile and therefore occupy minimum acreage compared with adults, which may rapidly disperse over large areas. By targeting the immatures, it is possible to minimize the area treated and often avoid treating populated areas.

Conversely, targeting adult mosquitoes may require highly visible and extensive applications of adulticides within residential and urban areas. The adulticides registered for this use are applied at levels 100 to 10,000 times below rates that would be cause for concern about exposure risk for the general public or the environment. Nevertheless, achieving good larval control while at the same time minimizing the use of adulticides is environmentally and client friendly, and appreciated by the public. Most states have specific regulations governing the decision to apply pesticides for mosquito control. These usually involve the collection of data that substantiate the need for the application. Thus, standardized ultra-low-volume (ULV) operation on a fixed schedule is not allowed in most areas. Each application must be justified by documentation of increased mosquito activity, such as trap collections, landing or biting counts, telephone complaints, etc.

Mosquito Repellents

The CDC traveler's page on preventing dengue fever suggests using mosquito repellents that contain DEET (N, N-diethylmetatoluamide, between 20% to 30% concentration, but not more). It also suggests the following:

1. The mosquito usually bites at dusk and dawn but may bite at any time during the day – especially indoors, in shady areas, or when the weather is cloudy.
2. The mosquito's preferred breeding areas are in areas of stagnant water, such as flower vases, uncovered barrels, buckets, and discarded tires, but the most dangerous areas are wet shower floors and toilet tanks, as they allow the mosquitos to breed in the residence. Research has shown that certain chemicals emanating from bacteria in water containers stimulate the female mosquitoes to lay their eggs. They are particularly motivated to lay eggs in water containers that have the correct amounts of specific fatty acids associated with bacteria involved in the degradation of leaves and other organic matter in water. The chemicals associated with the microbial stew are far more stimulating to discerning female mosquitoes than plain or filtered water in which the bacteria once lived.
3. Wear long-sleeved clothing and long trousers when outdoors during the day and evening.
4. Spray permethrin or DEET repellents on clothing, as mosquitos may bite through thin clothing.
5. Use mosquito netting over the bed if the bedroom is not air conditioned or screened. For additional protection, treat the mosquito netting with the insecticide permethrin.
6. Spray permethrin or a similar insecticide in the bedroom before retiring.

Foul Water Mosquito *(Culex stigmatosoma)*
Adult females feed predominantly on birds at night.

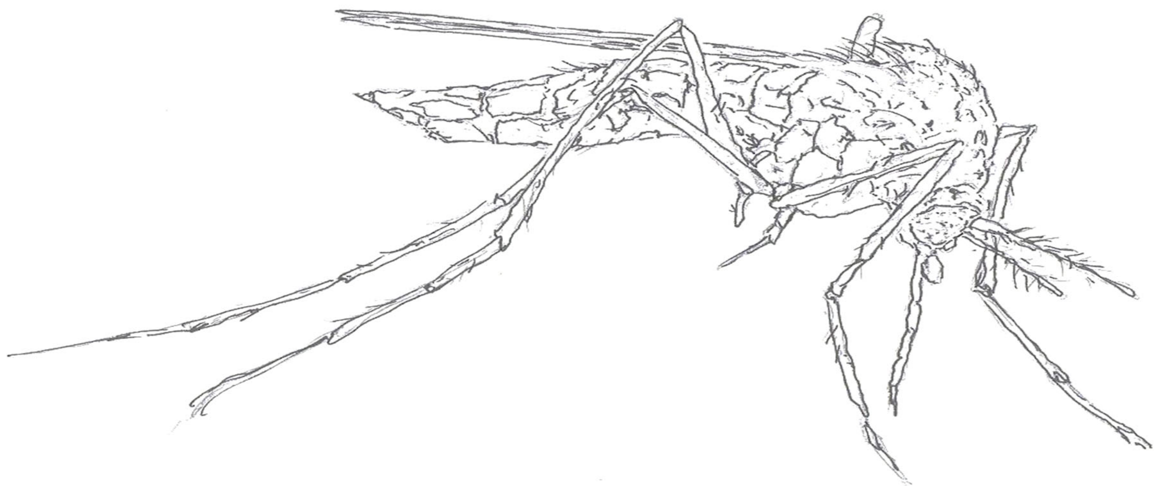
Culex stigmatosoma is known as the Banded Foul Water Mosquito due to its association with polluted water and can be found in most California counties. The Banded Foul Water Mosquito is a dark bodied, medium-sized mosquito with a prominent white band on its proboscis (beak) and white bands on the tarsi (feet). It is further characterized by black scales which form "o" spots on the underside of the blunt-tipped abdomen. This mosquito most closely resembles Culex tarsalis but lacks the white stripe on the hind legs.

Adult Daily Activity
These mosquitoes may live for two or three weeks in the summer, but under cooler conditions the females may live for several months. In areas of moderate climate, adults and larvae may be found in every month of the year, but in areas with cold winters this species usually passes the winter as hibernating females in protected natural or artificial shelters such as cellars, outbuildings, wood piles, caves, culverts, etc. Mating may take place in conjunction with the male swarms.

Adult Flight Range
This species is capable of traveling 1-2 miles to seek a host, but is most commonly found near its aquatic habitat. The maximum recorded flight range is less than ten miles.

Adult Feeding
Female foul water mosquitoes seem to prefer feeding on birds, but on occasion will feed on livestock and humans. Males feed on nectar and plant juices. Females may also feed on plant juices, but usually must have a blood meal in order to develop their eggs. Nighttime is the peak feeding time for females of this species.

Eggs and Larvae
An adult female lays about 150-200 eggs in clusters called rafts, which float on the surface of the water until they hatch in about one to two days. The female usually prefers laying eggs in standing, polluted water such as sewage, street drainage, industrial wastes, dairy ponds, log ponds and backyard sources such as unused swimming pools, fouled ornamental ponds, cooler drain-water, and water in containers. A wide variety of other water sources may also be infested with the aquatic stages of this common mosquito.



FLOODWATER MOSQUITO

Disease Vector
Foul Water Mosquitoes do occasionally create domestic, industrial and agricultural pest problems when they are present in large numbers. Although Western Equine Encephalitis and St. Louis Encephalitis have been isolated from natural populations of these mosquitoes, their reluctance to bite humans reduces their efficiency as disease carriers. This species has recently been identified as a carrier of West Nile Virus, a mosquito-borne disease that is rapidly spreading across the United States.

Life Cycle
Foul Water Mosquitoes have four life stages: egg, larva, pupa, and adult. The immature stages need standing water to complete their life cycle. After an adult female lays her eggs they hatch into larvae (wrigglers), which feed on small organic particles and microorganisms in the water.

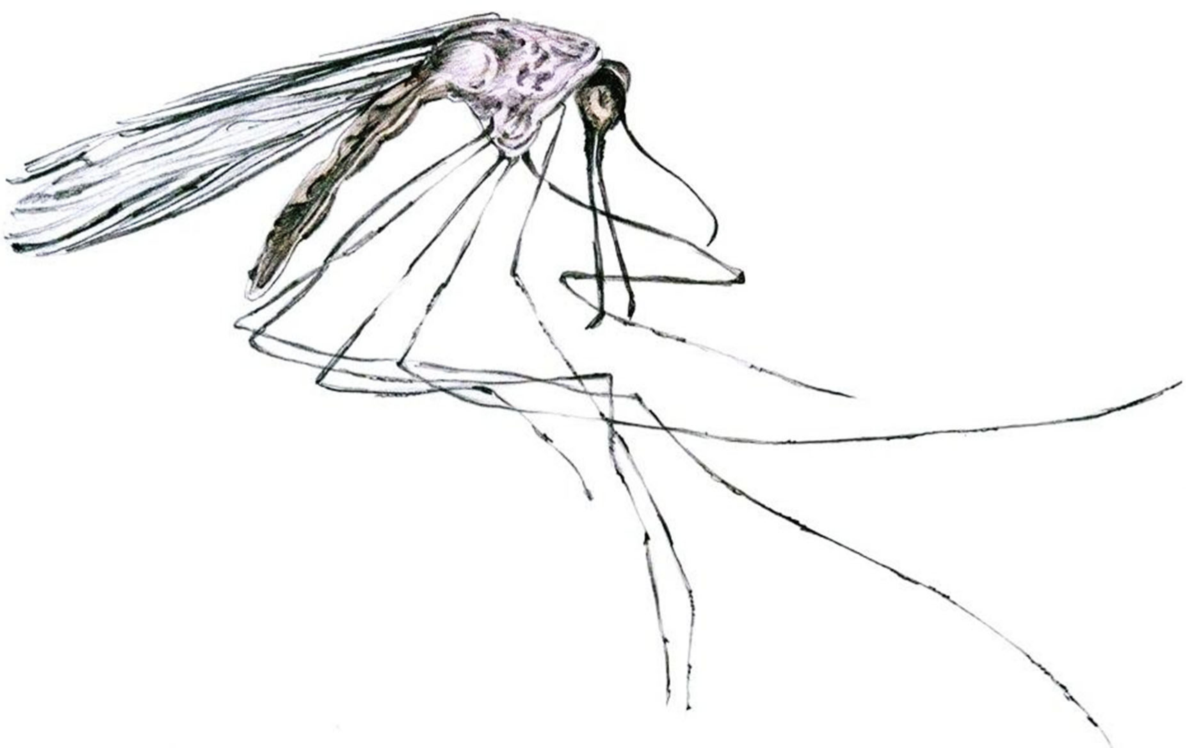
Feeding occurs when they hang from the water's surface by the tip of their tail (siphon) or by browsing along the bottom of their habitat. Because they are air breathing organisms they must return to the water's surface to breathe. About one to two weeks are required for larval development. At the end of the larval stage, the mosquito molts and becomes the aquatic pupa (tumbler).

The pupa is active only if disturbed, for this is the resting stage where the larval form is transformed into the adult. This takes about two days during which time feeding does not occur. When the transformation is completed, the new adult splits the pupal skin and emerges. Under optimum conditions, development from egg to adult takes about a week.

However, all mosquito developmental times are dependent on the temperature and nutrients of the water in which they mature. Where possible, the best approach is to prevent mosquitoes from breeding by eliminating or modifying breeding sites. This can be accomplished best by eliminating containers which are capable of holding water. Where breeding sites exist in standing or slow-moving water, corrective action to permanently eliminate them by such means as filling, pumping, ditching or draining is recommended. Close coordination with your local mosquito abatement district and environmental regulatory authorities is recommended.

Inland Floodwater Mosquito (*Aedes vexans*)

They are opportunistic feeders, taking blood meals from a variety of animals as available, but apparently preferring larger mammals, including cattle, horses, deer, and humans when present.



The name "*vexans*" is from the Latin word "*vexāre*" meaning to annoy, torment, or harass. In many parts of the world, this species is a major nuisance, the females biting in the evening, peaking in activity an hour or so after sunset. They are opportunistic feeders, taking blood meals from a variety of animals as available, but apparently preferring larger mammals, including cattle, horses, deer, and humans when present.

This is a medium sized brown mosquito with v-shaped notches in the upper abdomen scales. It is one of the most common floodwater mosquitoes and a reported problem species in most states. They are vicious biters and can harbor many viruses including SLE, WEE, eastern equine encephalitis (EEE), and La Cross encephalitis (LAC), in addition to WNV.

Eggs are laid in mud and hatch when flooded in the spring or early summer. Several hatches may occur each season as water levels recede and rise, however the eggs can remain viable for several years if flooding does not occur.

Larval habitat: Floodwaters, irrigated pastures and other grassland pools
Biting time: dusk through dawn
Preferred host: Birds and mammals
Flight range: 5 to 15 miles from breeding site

A. vexans is a known vector of *Dirofilaria immitis* (dog heartworm), myxomatosis (a deadly rabbit viral disease), and Tahyna virus, a seldom-diagnosed *Bunyaviridae* virus, which affects humans in Europe, causing a fever which disappears after 2 days, but afterward can cause encephalitis or meningitis.

A. vexans is the most common mosquito in Europe, often comprising more than 80% the European mosquito community. Its abundance depends upon availability of floodwater pools.

In summer, up to 8,000 mosquitoes can be collected per trap per night. *A. vexans* exhibited significantly higher transmission rates of Zika virus than *A. aegypti*, and its wide geographic distribution, periodic extreme abundance, and aggressive human biting behavior increase its potential to serve as a Zika virus vector in northern latitudes outside the range of the primary vectors *A. aegypti* and *A. albopictus*.

Aedes vexans is often one of the first mosquito species that new surveillance technicians learn to identify – abundant in the trap samples early in the season, very distinctly marked, and easy to recognize. Against a background of black scales, this mosquito has narrow white bands on the base of each leg segment, and the base of most abdominal segments is adorned with white-scaled bands, indented in the middle so that they look like the letter "B" when viewed sideways.

Japanese Rockpool Mosquito (*Aedes japonicus*)

Being a day feeder, it prefers humans and mammals for its blood meal.

Aedes japonicus is an Asian species of mosquito generally found in Japan, Korea, the Ryukyu Archipelago (Okinawa and associated islands), Taiwan, South China, and Hong Kong. In 1998, the subspecies Aedes japonicus japonicus was first detected in the United States in New York and New Jersey. Since that time, Aedes japonicus has been found in six other states: Ohio, Maryland, Connecticut, Massachusetts, Pennsylvania, and Virginia.

Appearance

The adult female of Aedes japonicus is a medium-sized mosquito of dark- to blackish-brown appearance, with white scales on the body and legs.

Breeding Areas

Larvae are found in a wide variety of natural and artificial containers, including rock holes and used tires. Preferred sites usually are shaded and contain water rich in organic matter. The similarity of breeding habitats used by Aedes japonicus to those of other Aedes species suggests that the transport of eggs, larvae, and pupae in used tires may be an important mechanism for introducing the species into previously uninfested areas.

Eggs are resistant to desiccation and can survive several weeks or months under dry conditions. Aedes japonicus overwinters as eggs in the more northern parts of its range. However, it is found throughout the winter as larvae as far north as Tokyo (37° N), which is equal in latitude to Norfolk, Virginia.

Disease Associations
Although few studies have been done to assess the public and veterinary health importance of Aedes japonicus, this species is suspected of being a vector of Japanese encephalitis (JE) virus to swine in northern Japan. Under experimental conditions it has been shown to transmit JE virus to mice and also to transmit the virus to its progeny through the eggs.

Unpublished studies conducted at the United States Army Medical Research Institute of Infectious Diseases in Fort Detrick, MD, indicate that Aedes japonicus is also a competent experimental vector of West Nile virus, a flavivirus closely related to JE and St. Louis encephalitis viruses.

Behavior
Adult species of Aedes japonicus rest in wooded areas and prefer to bite during the daytime. In the laboratory, they feed readily on chicks and mice, but not on reptiles or amphibians. Further studies on Aedes japonicus are needed to more clearly define their feeding preferences in a variety of situations.

Protection
As with other biting insects, the use of protective clothing (i.e., long-sleeved shirts and long pants) and insect repellent is recommended to prevent bites.

Key Mosquito in Minnesota
Faced with a new mosquito species that could transmit disease in Minnesota, state health and mosquito control officials are urging residents to rid their property of water-holding containers. The Minnesota Department of Health (MDH) and the Metropolitan Mosquito Control District (MMCD) confirmed that the Japanese rock pool mosquito (*Aedes japonicus*) is established in at least five southeastern Minnesota counties. This mosquito could potentially transmit LaCrosse encephalitis virus (LAC) and West Nile virus (WNV) to humans.

"Spring is the perfect time to take simple steps to prevent mosquito-transmitted disease later this summer," said David Neitzel, an MDH epidemiologist who specializes in mosquito-borne diseases. "Several types of disease-carrying mosquitoes use water-holding containers, such as old tires, buckets, or cans, as breeding sites.

If everyone dumps the water out of these containers and removes them during their spring yard work, we can reduce the number of mosquitoes that could transmit disease later this summer."

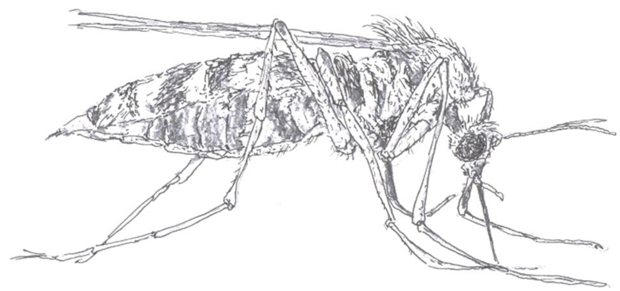
The Japanese rock pool mosquito, an Asian mosquito that was accidentally imported into this country, has been steadily moving across the United States since it was first found in New Jersey in 1998. It was first identified in Minnesota in Scott County in 2007. During 2008, it was also detected in Dakota, Goodhue, Wabasha and Houston counties. This spring, it was determined that these mosquitoes' eggs had survived the Minnesota winter. "We suspect that we will soon find this mosquito in other counties as well," Neitzel said.

Northern House Mosquito or House Mosquito (*Culex pipiens)*

It is a vector for diseases, including Japanese encephalitis, amplify the infection in urban birds.

Common Associate Species: *Cx. restuans, Cs. inornata, An. punctipennis*

Culex pipiens, the Northern House Mosquito has a distribution that roughly includes the northern half of the United States. This species' range begins just north of Maine, along the Atlantic seaboard, and extends to the state of Washington in the west with some extension into southern British Columbia. The range along the Pacific coast extends into northern California and then east on a relatively straight line to North Carolina. The species is replaced by *Culex quinquefasciatus*, the Southern House Mosquito, in the southern United States with limited overlap in portions of the Midwest.



MOSQUITO *(culex pipiens)*

This species is medium-sized, brownish with pale bands around the abdominal segments. The quickly developing larvae may be continuously present spring through fall. Although they occur in rural environments, they reach their greatest numbers in urban and suburban areas and readily enter homes. Culex pipiens are known to vector St. Lewis encephalitis (SLE).

Larval Habitats

Nearly anything retaining water, clean or polluted— artificial containers, catch basins, ground pools, animal waste lagoons, tires, hoof prints, etc.

Biting time: Night
Preferred host: Mostly birds, but will readily bite mammals, including humans
Flight range: ¼ to ½ mile from breeding site

Culex pipiens provides the life cycle model for most of the domestic *Culex* in temperate areas. Inseminated adult females from the last generation of the season build body fat by feeding on carbohydrates and enter hibernation in fall. The females pass the winter in diapause and do not become active during periods of warm winter weather. Hibernating females are common in basements, outbuildings, and subterranean enclosures. Like *Culex restuans*, the females congregate near moisture and move their resting location during the winter to remain in a humid atmosphere.

Mortality can be extensive during periods of winter drought. Females emerge from hibernation during May and begin depositing egg rafts in suitable habitat. Populations of this mosquito usually peak during August, but breeding continues well into September. The adults from the last generation of the season lose all interest in blood meal hosts but will move in and out of overwintering sites during periods of mild fall weather. Larvae rarely persist in breeding habitats after females have entered hibernation.

Culex pipiens can be found in a fairly wide range of larval habitats, but are generally associated with water that has a high organic content. The species utilizes temporary ground water that ranges from mildly to grossly polluted. The species also deposits its eggs in artificial containers, including tin cans, tires, and any refuse that allows stagnant water to puddle. The species is decidedly urban and reaches greatest numbers in large urban centers. Catch basins and storm drains provide ideal habitat for *Cx. pipiens*. The species becomes particularly abundant in areas where raw sewage leaks into subterranean drainage systems.

Meat packing plants and slaughter house drainage ponds support high populations of this species. *Culex pipiens* can always be collected in the effluent from sewage treatment plants.

Collection
No special techniques are required to collect *Cx. pipiens* larvae. This species is common in urban settings and can usually be found in significant numbers in a variety of habitats where stagnant water collects. *Culex pipiens* will oviposit readily in buckets containing prepared straw infusions. Most piles of discarded tires contain a mixture of *Cx. pipiens* and *Cx. restuans* in addition to the tire-breeding *Aedes*.

Culex pipiens occurs on every continent except Antarctica and is the most widely distributed mosquito in the world. In North America, two races range north (*Cx. pipiens pipiens*) and south (*Cx. pipiens quinquefasciatus*) of 39ºN latitude, about the level of Sacramento. *Cx. p. pipiens* lives in the milder coastal climate areas, while *Cx. p. quinquefasciatus* is found in the warmer inland valleys.

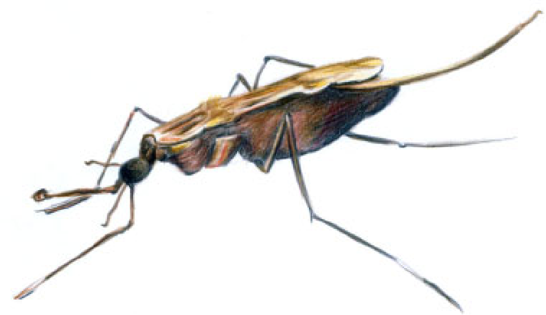
***Culex pipiens*'** main host is wild birds, but it also feeds freely on a wide variety of warm-blooded vertebrates, including man. In northern California, it currently plays only a lesser role as a carrier of human disease, while in southern California and the Gulf Coast region, it is a major carrier of Saint Louis encephalitis. It is also the best known carrier of West Nile Virus, a severe encephalitis virus newly arrived in the Americas that is spreading along the eastern seaboard.

Culex pipiens is a serious pest, called the "*house mosquito*" because it commonly develops in small containers around the home. It shows great skill in finding ways to get into the house, where it feeds on the occupants at night. It also occurs in containers and sumps on farms and industrial plants, in polluted waters, and will feed out-of-doors at night.

Culex pipiens larvae typically develop best in dirty, stagnant water containing abundant organic matter, in ground pools and natural and man-made containers. Vector technicians often find improperly installed or maintained underground septic tanks producing huge numbers of this species.

The mosquitoes gain entrance thorough cracks in the ground, through poorly fitting or unsealed covers, or by the vent pipes made for removal of gases. We recommend that all vents be covered with window screening, preferably aluminum screen, to exclude adults. Polluted habitats do not generally support a very wide variety of species. Most larval samples from polluted water sources consist mainly of *Cx. pipiens* and *Cx restuans*. *Culex pipiens* larvae are easily distinguished from *Cx. restuans* by the length and shape of the antennae.

Culex tarsalis is widely distributed in North America west of the Mississippi River, between southern Canada and northern Mexico. It primarily occurs throughout California, from sea level up to nearly 10,000 in feet elevation, and is especially abundant in the Central Valley and coastal regions, including Marin and Sonoma Counties.



As its name suggests, *C. tarsalis* has bands of white scales around the joints of its tarsi (legs).

There is also a pale band around the center of the proboscis, a line of white scales extending along the hind tibia and femur, and a series of V-shaped spots made of dark scales on the underside of each abdominal segment.

This mosquito develops rapidly and produces multiple generations. In the hot summer season, egg to adult development occurs in as few as four to ten days. A female can lay six or seven times, with some 300 eggs in a batch. Without control efforts, local populations can reach huge numbers in a short time.

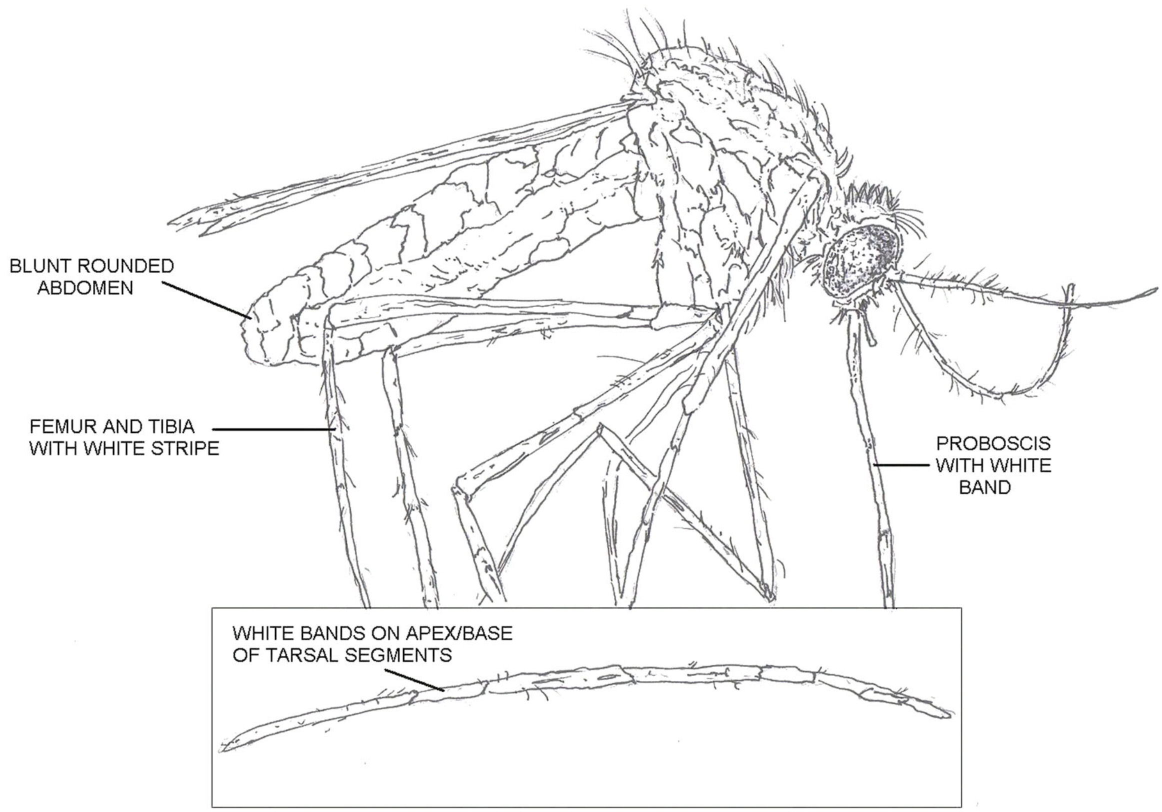
Culex tarsalis breeds in nearly every freshwater source except treeholes. Larvae are found in all but the most polluted ground pools.

Summer agricultural irrigation produces an especially favorable environment, with highest population densities coinciding with the months of most intense irrigation.

During the daytime, adults rest in tree cavities, animal burrows, and artificial habitats like barns, chicken houses, and culverts. In most areas, they feed equally on birds and mammals, including man, depending on availability. After years of intense efforts to keep them under control, vast populations in the central valley have become resistant to nearly all the common chemical insecticides.

Culex tarsalis is the most important carrier of western equine and Saint Louis encephalitis in much of the western U.S. It occurs together with wild birds - the natural reservoir of infection, and the virus is often discovered in field-collected specimens. It is also readily infected after taking an infected blood meal, and easily transmits the virus during its later blood meals.

The appearance of antibodies against encephalitis virus in the flocks of sentinel chickens kept in several parts of the state is a signal alarm to the districts to begin quickly and aggressively reducing *Culex tarsalis* numbers around populated areas.



Mosquitoes of the *Culex tarsalis* species have a distinct ring around the proboscis.

Also, they have apical and basal tarsal bands. With 11 species, Culex is one of the largest genus of mosquitoes. Females of this group have short palpi and a blunt, rather than pointed abdomen.

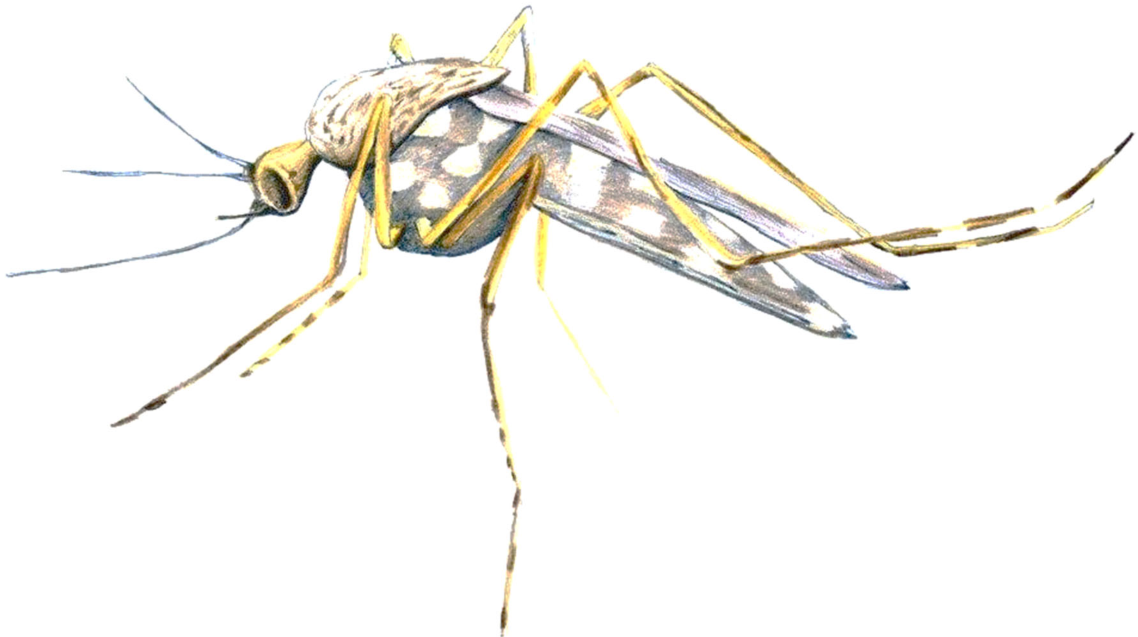
Unlike most Ochlerotatus, they tend to have numerous generations in a year. Several hundred eggs are laid packed together in rafts. A female can lay six or seven times in her forty to fifty-day life span.

Where does this Mosquito normally lay its Eggs?

- In tin cans, buckets, discarded tires and other artificial containers that hold stagnant water.
- In untended bird baths, clogged rain gutters and plastic wading pools that hold stagnant water.
- In storm drains and catch basins in urban areas.
- In septic seepage and other foul water sources above or below ground level.

Pale Marsh Mosquito (*Ochlerotatus dorsalis)*

Prefers to feed on large mammals like cattle, horses and man.



Ochlerotatus dorsalis

Ochlerotatus dorsalis' common name comes from its whitish-grey appearance: the abdomen and wings have intermixed narrow light and dark scales. Sometimes the light scales predominate. The hind legs have pale white bands overlapping the individual joints. This mosquito is found in Asia, Europe, and North America.

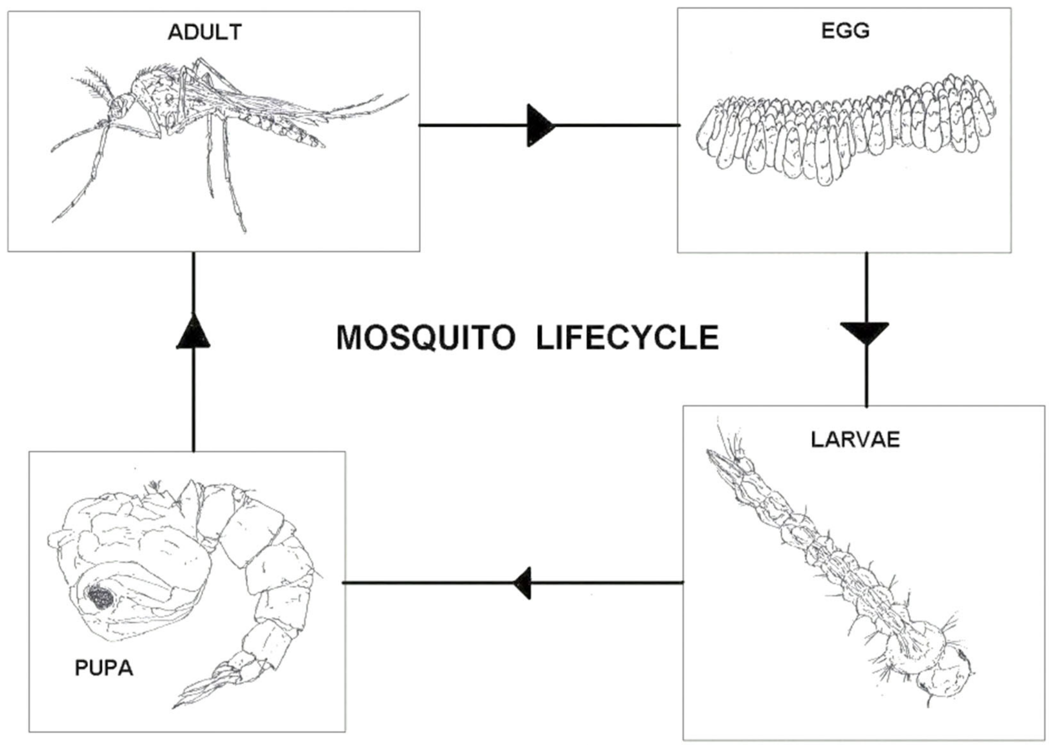
In California, it occurs along the Pacific coast and in the eastern regions of the state. It breeds along the edges of bays, marshes and lakes. It is especially frequent in the seasonally flooded marshes along the edges of the San Francisco and San Pablo Bays.

A strong flyer, ***Ochlerotatus dorsalis*** often disperses 20 miles or more from its breeding sources. Unlike most other local *Ochlerotatus*, the pale marsh mosquito is active almost year-around. Females produce continuous broods throughout the spring and summer, with 8 to 12 hatches each year, and the last adults emerging in October.

Pre-adult stages can be as short as 1 to 2 weeks in the warm summer weather. Populations sometimes build up to huge numbers in brackish marshes subject to prolonged spring flooding.

Ochlerotatus dorsalis is a serious pest mosquito and a secondary vector of the encephalitis virus. Females prefer to feed on large mammals like cattle and horses (and man) when these are available.

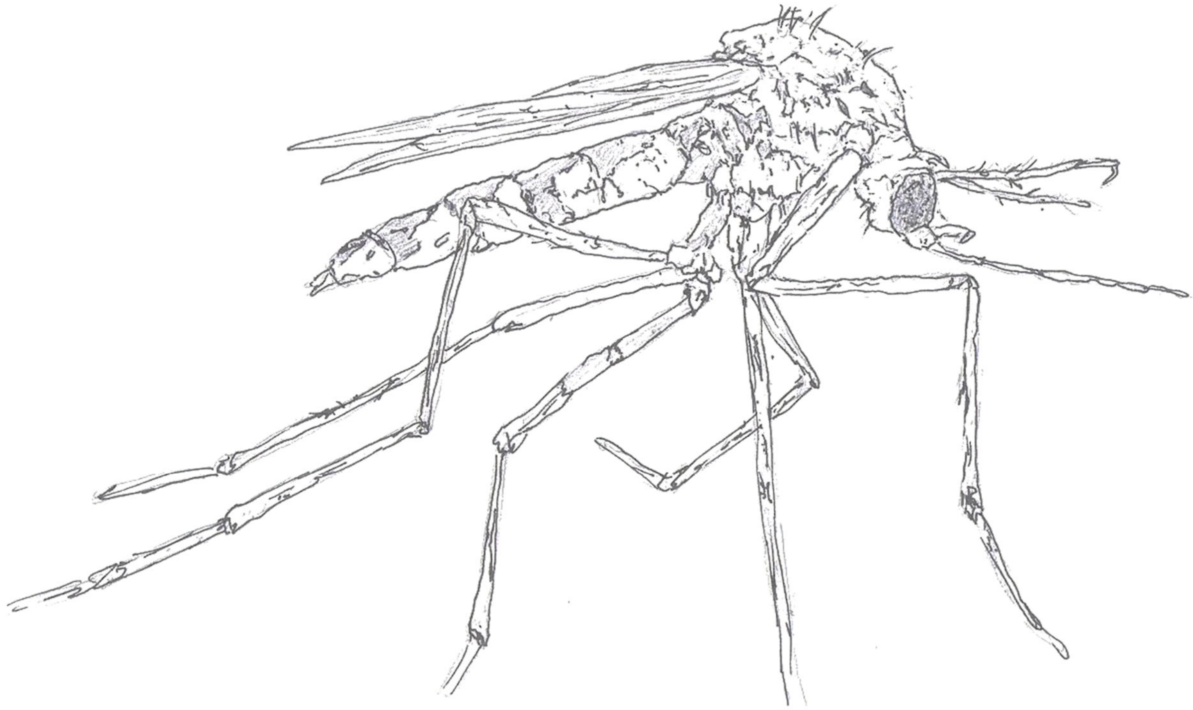
They are vicious biters, and so aggressive and persistent that livestock tend to move away from areas where they are numerous.



OCHLEROTATUS FITCHII

Salt Marsh Mosquito, Aedes (*Ochlerotatus taeniorynchus*)

Salt Marsh Mosquitoes May Live 100 Miles Away.



SALT MARSH MOSQUITO

The major salt marsh mosquito, Aedes (Ochlerotatus) taeniorynchus, is known for its fierce biting plus synchronized egg laying and hatching patterns that produce large swarms. Adult mosquitoes are small, fragile insects with slender bodies; one pair of narrow wings (tiny scales are attached to wing veins); and three pairs of long, slender legs. They vary in length from 3/16 to 1/2 inch.

Mosquitoes have an elongate "beak" or piercing proboscis. Eggs are elongate, usually about 1/40-inch-long, and dark brown to black near hatching. Larvae or "wigglers" are filter feeders that move with an S-shaped motion. Larvae undergo four growth stages called instars before they molt into the pupa or "tumbler" stage. Pupae are comma-shaped and nonfeeding and appear to tumble through the water when disturbed.

Where possible, the best approach is to prevent mosquitoes from breeding by eliminating or modifying breeding sites. This can be accomplished best by eliminating containers which are capable of holding water. Where breeding sites exist in standing or slow-moving water, corrective action to permanently eliminate them by such means as filling, pumping, ditching or draining is recommended.

Close coordination with your local mosquito abatement district and environmental regulatory authorities is recommended. An important consideration in the practice of mosquito control is the advisability, whenever possible, to target control operations against immature populations. These stages are usually concentrated, relatively immobile and therefore occupy minimum acreage compared with adults, which may rapidly disperse over large areas.

By targeting the immatures, it is possible to minimize the area treated and often avoid treating populated areas. Conversely, targeting adult mosquitoes may require highly visible and extensive applications of adulticides within residential and urban areas.

The adulticides registered for this use are applied at levels 100 to 10,000 times below rates that would be cause for concern about exposure risk for the general public or the environment. Nevertheless, achieving good larval control while at the same time minimizing the use of adulticides is environmentally and client friendly, and appreciated by the public. Most states have specific regulations governing the decision to apply pesticides for mosquito control. These usually involve the collection of data that substantiate the need for the application. Thus, standardized ultra-low-volume (ULV) operation on a fixed schedule is not allowed in most areas. Each application must be justified by documentation of increased mosquito activity, such as trap collections, landing or biting counts, telephone complaints, etc.

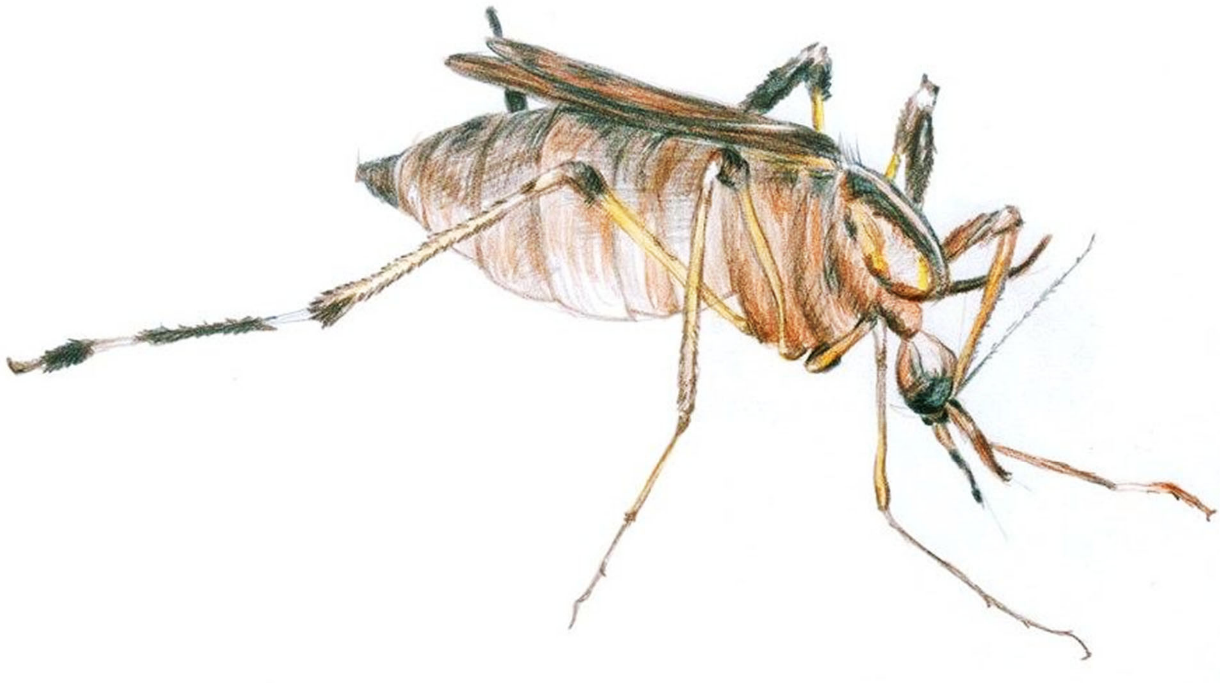
Mosquito Repellents

The CDC traveler's page on preventing dengue fever suggests using mosquito repellents that contain DEET (N, N-diethylmetatoluamide, between 20% to 30% concentration, but not more). It also suggests the following:

1. The mosquito usually bites at dusk and dawn but may bite at any time during the day – especially indoors, in shady areas, or when the weather is cloudy.
2. The mosquito's preferred breeding areas are in areas of stagnant water, such as flower vases, uncovered barrels, buckets, and discarded tires, but the most dangerous areas are wet shower floors and toilet tanks, as they allow the mosquitos to breed in the residence. Research has shown that certain chemicals emanating from bacteria in water containers stimulate the female mosquitoes to lay their eggs. They are particularly motivated to lay eggs in water containers that have the correct amounts of specific fatty acids associated with bacteria involved in the degradation of leaves and other organic matter in water. The chemicals associated with the microbial stew are far more stimulating to discerning female mosquitoes than plain or filtered water in which the bacteria once lived.
3. Wear long-sleeved clothing and long trousers when outdoors during the day and evening.
4. Spray permethrin or DEET repellents on clothing, as mosquitos may bite through thin clothing.
5. Use mosquito netting over the bed if the bedroom is not air conditioned or screened. For additional protection, treat the mosquito netting with the insecticide permethrin.
6. Spray permethrin or a similar insecticide in the bedroom before retiring.

Shaggy-legged" Gallinipper (*Psorophora ciliate*)

This creature is aggressive towards humans.



Is the largest blood sucking mosquito in the U.S. Commonly referred to as the "Shaggy-legged" Gallinipper. It is easy to identify by its large size and it inflicts a painful bite. Rarely found in large numbers. The larvae are large and are predacious upon other larvae.

Larval habitat: Breeds in fields, temporary ground pools, and ditches.
Adult habitat: Fields and yards
Biting activity: Anytime of the day when disturbed.
Flight range: 1-2 miles

Not only are these mosquitoes aggressive towards humans and other animals as adults, but *P. ciliata* larvae are known for preying on other mosquito species' larvae and even tadpoles. Campos, Fernandez, and Sy found in their 2004 study that *P. ciliata* were frequent predators to the mosquito species *Ochlerotatus albifasciatus* in Buenos Aires, Argentina and impact the populations of *O. albifasciatus*.

Females are aggressive, preferring to feed on large mammals, and are most active during spring and summer in woodlands or fields during the day or night. They lay eggs either as single eggs on moist soil, or as an egg raft on top of ephemeral pools of water. Typically, females in the genus are capable of laying their eggs on dry or damp land to hatch months or years later, depending on the species.

Snow Mosquito (*Culisetain ornate*)

Feeds off of the blood of mammals and birds, prefer to operate in forested areas.

SNOW MOSQUITO

This species also rather large, grayish-brown with broad, pale-scaled wings. The fertilized females hibernate in winter and emerge during warm spells, even when snow is still on the ground. It continues to breed throughout spring and summer. Known to vector WEE and is implicated in WNV.

Larval habitat: often in cold, fairly clean water
Biting time: Dusk through dawn, temperature influenced
Preferred host: Wild and domestic mammals, usually not humans
Flight range: unknown

Southern House Mosquito (*Culex quinquefasciatus*)

Vector of lymphatic filariasis and a number of arboviruses including St. Louis encephalitis virus and West Nile virus.

The *Culex pipiens* complex is distributed worldwide and has two species formally recognized in the complex. One of these species is the tropical and subtropical *C. quinquefasciatus* (the southern house mosquito), vector of lymphatic filariasis and a number of arboviruses including St. Louis encephalitis virus and West Nile virus.

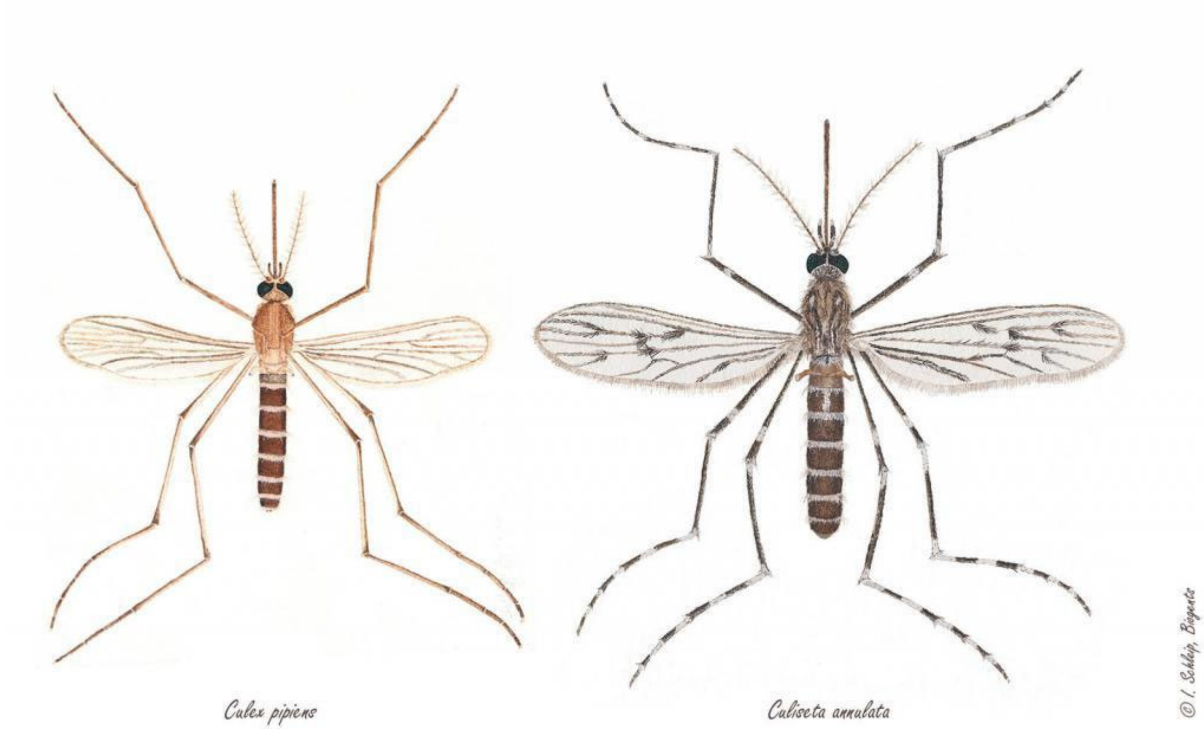
The adult *Culex quinquefasciatus* mosquito is a medium-sized, brown mosquito. The body is about 3.96 to 4.25 mm long. While the main body is brown, the proboscis, thorax, wings, and tarsi are darker than the rest of the body. The head is light brown with the lightest portion in the center.

Mature *Culex quinquefasciatus* females fly at night to nutrient-rich standing water to lay eggs. The larvae feed on organic material in the water and require between 5 to 8 days to complete their development at 30°C.

The larvae pass through four larval instars, and towards the end of the fourth instar they stop eating and undergo molting to give rise to pupae. After 36 hours (at 27°C) adults emerge. The exact timing of development can vary depending on temperature. Both males and females take nectar from plants, but after mating, the females seek a blood meal from mammals or birds. Ingested blood is necessary for egg development.

A single female can lay up to five rafts of eggs in a lifetime, with each raft containing thousands of eggs. The exact number varies depending on climatic conditions. It breeds profusely in dirty water collections, including stagnant drains, cesspools, septic tanks with leaks, borrow pits, and almost all organic polluted water sources. Under optimum temperature and humidity, the life cycle will be completed in 7 days, passing through the egg, larva, pupa, and adult stages.

Culex quinquefasciatus mosquitoes transmit zoonotic diseases that affect humans and other animals. These include **St. Louis encephalitis, Western equine encephalitis**, and **West Nile fever**. Infection occurs during feeding on blood. In southern U.S. it is the primary vector of St. Louis encephalitis virus.


Culex pipiens
Culiseta annulata
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Tule Mosquito (*Culex erythrothorax*)

Vector of West Nile virus, Japanese encephalitis, or St. Louis encephalitis, but also filariasis and avian malaria.

Culex erythrothorax is a mosquito species that appears in Southern California. It is also known as the tule mosquito, due to its preference for breeding in tule plants. The species has a brownish-orange color. It is a confirmed vector of West Nile virus.

Culex is a genus of mosquitoes, several species of which serve as vectors of one or more important diseases of birds, humans, and other animals. The diseases they vector include arbovirus infections such as West Nile virus, Japanese encephalitis, or St. Louis encephalitis, but also filariasis and avian malaria. They occur worldwide except for the extreme northern parts of the temperate zone, and are the most common form of mosquito encountered in some major U.S. cities, such as Los Angeles.

Depending on the species, the adult *Culex* mosquito may measure from 4–10 mm (0.2–0.4 in). The adult morphology is typical of flies in the suborder Nematocera with the head, thorax, and abdomen clearly defined and the two forewings held horizontally over the abdomen when at rest. As in all Diptera capable of flight, the second pair of wings is reduced and modified into tiny, inconspicuous halteres.

Formal identification is important in mosquito control, but it is demanding and requires careful measurements of bodily proportions and noting the presence or absence of various bristles or other bodily features.

In the field, informal identification is more often important, and the first question as a rule is whether the mosquito is anopheline or culicine. Given a specimen in good condition, one of the first things to notice is the length of the maxillary palps. Especially in the female, palps as long as the proboscis are characteristic of anopheline mosquitoes. Culicine females have short palps.

Anopheline mosquitoes tend to have dappled or spotted wings, while culicine wings tend to be clear. Anopheline mosquitoes tend to sit with their heads low and their rear ends raised high, especially when feeding, while culicine females keep their bodies horizontal.

Anopheline larvae tend to float horizontal at the surface of the water when not in motion, whereas culicine larvae float with head low and only the siphon at the tail held at the surface.

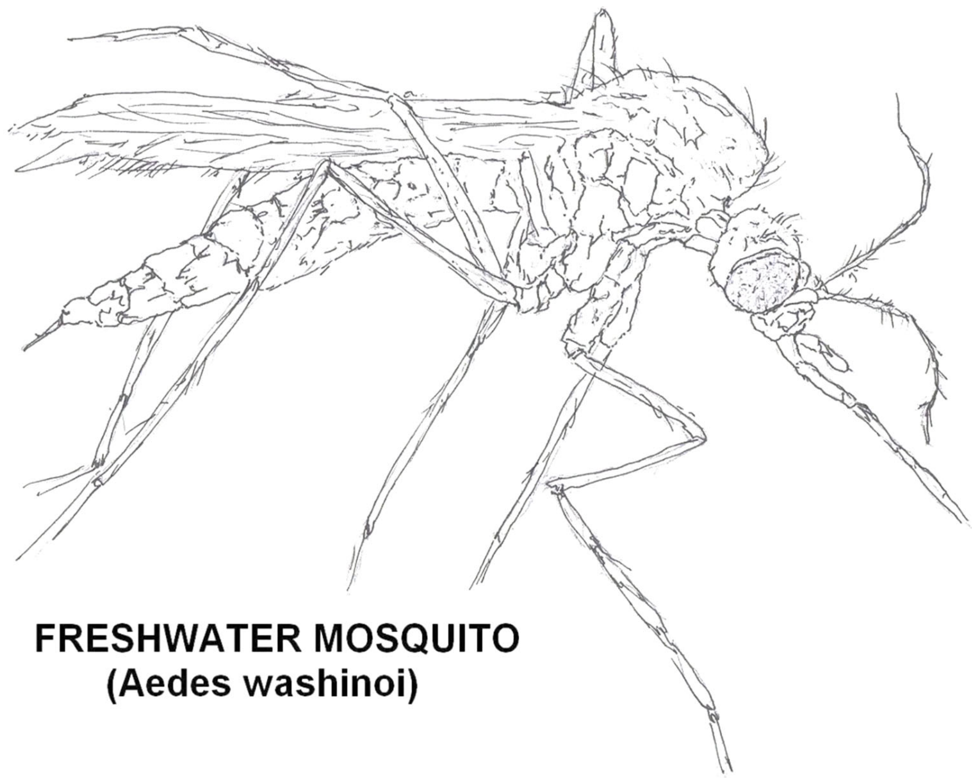
Life Cycle
The developmental cycle of most species takes about two weeks in warm weather. The metamorphosis is typical of holometabolism in an insect: the female lays eggs in rafts of as many as 300 on the water's surface.

Suitable habitats for egg-laying are small bodies of standing fresh water: puddles, pools, ditches, tin cans, buckets, bottles, and water storage tanks (tree boles are suitable for only a few species).

The tiny, cigar-shaped, dark brown eggs adhere to each other through adhesion forces, not any kind of cement, and are easily separated. Eggs hatch only in the presence of water, and the larvae are obligately aquatic, linear in form, and maintain their position and mostly vertical attitude in water by movements of their bristly mouthparts. To swim, they lash their bodies back and forth through the water.

During the larval stage, the insect lives submerged in water and feeds on particles of organic matter, microscopic organisms or plant material; after several instars it then develops into a pupa. Unlike the larva, the pupa is comma-shaped. It does not feed, but can swim in rapid jerking motions to avoid potential predators. It must remain in regular contact with the surface to breathe, but it must not become desiccated. After 24–48 hours, the pupa ruptures and the adult emerges from the shed exoskeleton.

Washino's Willow Pool Mosquitoes (*Aedes washinoi)*
Aggressive day-biting mosquito.



Washino's Willow Pool Mosquito (Aedes washinoi) is an aggressive day-biting mosquito commonly found breeding in shallow ground pools and riparian sites dominated by willow or cottonwood trees. This species has also been found breeding in areas with dense blackberry thickets.

Washino's Willow Pool Mosquitoes have four life stages: egg, larva, pupa, and adult. The immature stages need standing water to complete their life cycle. Washino's Willow Pool Mosquito does occasionally create domestic, industrial and agricultural pest problems when they are present in large numbers. Although California Encephalitis virus has been isolated from natural populations of these mosquitoes, no confirmed human cases of mosquito-borne disease has been linked to this species of mosquito.

Life Cycle
After an adult female lays her eggs they hatch into larvae (wrigglers), which feed on small organic particles and microorganisms in the water. Feeding occurs when they hang from the water's surface by the tip of their tail (siphon) or by browsing along the bottom of their habitat. Because they are air breathing organisms they must return to the water's surface to breathe.

About one to two weeks are required for larval development. At the end of the larval stage, the mosquito molts and becomes the aquatic pupa (tumbler). The pupa is active only if disturbed, for this is the resting stage where the larval form is transformed into the adult. This takes about two days during which time feeding does not occur. When the transformation is completed, the new adult splits the pupal skin and emerges.

Adult Daily Activity
Adults emerge during late winter and early spring and can persist through early June. Man-made canals and natural water ways have sometimes been used by these mosquitoes as a passage way into local human developments.

Adult Flight Range
Usually stay within one mile of their breeding site. Maximum recorded flight range 1.5 miles.

Adult
Feeding
Females tend to feed during the day and at dusk. Their preferred hosts are humans and large mammals.

Eggs and Larvae
Eggs are laid in the muddy margins adjacent to the receding water line of the larval habitat and hatch the following winter when re-flooded. Larvae usually hatch during early winter after sufficient rainfall has filled their habitat with enough water to submerge the last season and prior season's eggs.

Additional hatches of larvae can occur if late winter and early spring rains refill drying larval sites. Larva of this mosquito also exhibit a late fourth instar diapause and partial synchronous adult emergence similar to that observed in the Winter Salt Marsh Mosquito (Aedes squamiger).

Where possible, the best approach is to prevent mosquitoes from breeding by eliminating or modifying breeding sites. This can be accomplished best by eliminating containers which are capable of holding water. Where breeding sites exist in standing or slow-moving water, corrective action to permanently eliminate them by such means as filling, pumping, ditching or draining is recommended. Close coordination with your local mosquito abatement district and environmental regulatory authorities is recommended.

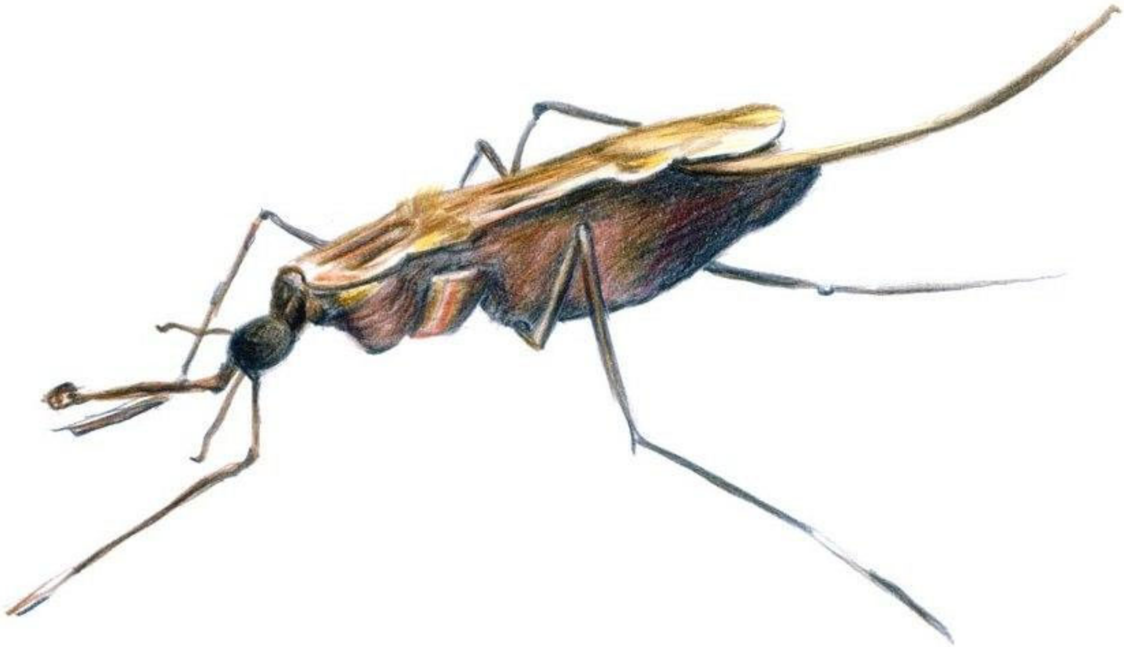
An important consideration in the practice of mosquito control is the advisability, whenever possible, to target control operations against immature populations. These stages are usually concentrated, relatively immobile and therefore occupy minimum acreage compared with adults, which may rapidly disperse over large areas.

By targeting the immatures, it is possible to minimize the area treated and often avoid treating populated areas. Conversely, targeting adult mosquitoes may require highly visible and extensive applications of adulticides within residential and urban areas. The adulticides registered for this use are applied at levels 100 to 10,000 times below rates that would be cause for concern about exposure risk for the general public or the environment.

Nevertheless, achieving good larval control while at the same time minimizing the use of adulticides is environmentally and client friendly, and appreciated by the public. Most states have specific regulations governing the decision to apply pesticides for mosquito control. These usually involve the collection of data that substantiate the need for the application. Thus, standardized ultra-low-volume (ULV) operation on a fixed schedule is not allowed in most areas. Each application must be justified by documentation of increased mosquito activity, such as trap collections, landing or biting counts, telephone complaints, etc.

Western Encephalitis Mosquito (*Culex tarsalis*)

Aggressive to humans and Animals, prefers birds.



This is medium-sized, dark mosquito that has a broad white band across the middle of the proboscis and the lower leg segments. In addition to being a potential vector of WNV this species is the most important vector of Western Equine encephalitis (WEE) and SLE.

Larval habitat: Nearly anything retaining water (see Culex pipiens)
Biting time: Most active at nightfall but also through until daylight
Preferred host: Mostly birds, but will readily bite mammals, including humans
Flight range: 5-15 miles

As mosquitoes go, the Western Encephalitis Mosquito is one of the more easily recognizable, with its distinctive scale patterns. The legs have white banding on each side of the joints, and the proboscis is adorned with a bright white band of scales in the middle. The purpose of these bands is unknown, but they may help the mosquito recognize potential same-species mates, or assist with orientation when flying, perching, and feeding on nectar-rich flowers.

Species in the genus *Culex* are known as “standing-water” mosquitoes. Unlike their “floodwater” relatives (such as *Aedes vexans*) that lay eggs above the water line, standing-water mosquitoes must lay their eggs directly on the water’s surface. *Culex* eggs are laid one at a time, but attached together to form a raft of 100 or more eggs. The structure of the individual eggs and the way in which they are attached together make the egg raft able to float on the water surface until they hatch, usually within a couple of days after being laid. These mosquitoes must have standing water for egg-laying and larval development. In the case of *Culex tarsalis*, which is highly opportunistic when it comes to seeking a water source, they usually occur in natural or man-made swamps, or other semi-permanent waters, often with high organic content. In the arid regions of the west, such watery habitats were uncommon prior to large-scale agriculture and urban development, making this species much more common today than it would have been historically.

Separating adult females of *Culex tarsalis* from *Culex coronator*			
		Culex tarsalis	***Culex coronator***
HEAD	Proboscis dark-scaled with a broad median white band	**X**	
	Proboscis dark-scaled dorsally and a broad area of pale or white scales ventrally		**X**
	Short palps, dark with white scales on the apical and the 3rd segments	**X**	
	Short, dark palps		**X**
LEGS	Hind tarsomeres with distinct basal and apical bands	**X**	**X**
	Anterior surface of fore femur and tibia with pale stripe of scales	**X**	
ABDOMEN	V-shaped dark-scaled pattern on abdominal sterna	**X**	
	Abdominal sterna without dark triangles; mostly pale scaled		**X**

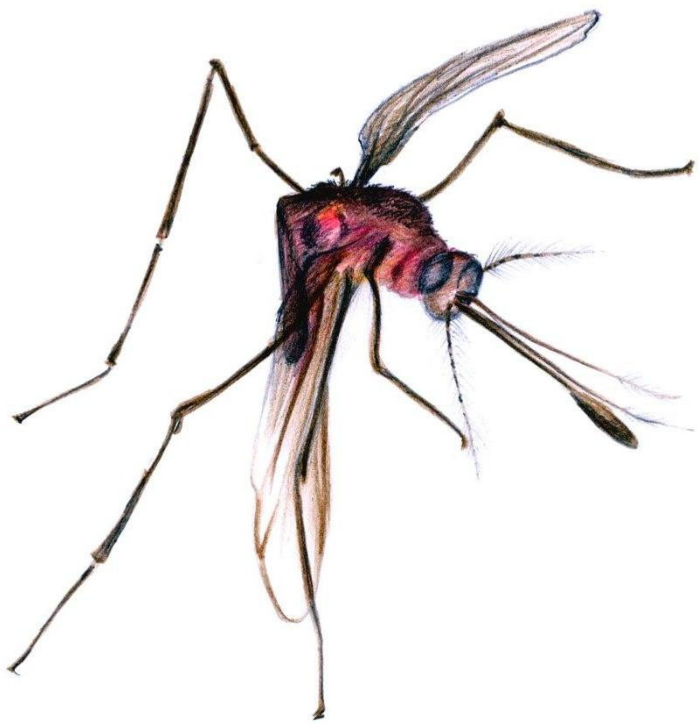
Mosquito Repellents

The CDC traveler's page on preventing dengue fever suggests using mosquito repellents that contain DEET (N, N-diethylmetatoluamide, between 20% to 30% concentration, but not more). It also suggests the following:

1. The mosquito usually bites at dusk and dawn but may bite at any time during the day – especially indoors, in shady areas, or when the weather is cloudy.
2. The mosquito's preferred breeding areas are in areas of stagnant water, such as flower vases, uncovered barrels, buckets, and discarded tires, but the most dangerous areas are wet shower floors and toilet tanks, as they allow the mosquitos to breed in the residence. Research has shown that certain chemicals emanating from bacteria in water containers stimulate the female mosquitoes to lay their eggs. They are particularly motivated to lay eggs in water containers that have the correct amounts of specific fatty acids associated with bacteria involved in the degradation of leaves and other organic matter in water. The chemicals associated with the microbial stew are far more stimulating to discerning female mosquitoes than plain or filtered water in which the bacteria once lived.
3. Wear long-sleeved clothing and long trousers when outdoors during the day and evening.
4. Spray permethrin or DEET repellents on clothing, as mosquitos may bite through thin clothing.
5. Use mosquito netting over the bed if the bedroom is not air conditioned or screened. For additional protection, treat the mosquito netting with the insecticide permethrin.
6. Spray permethrin or a similar insecticide in the bedroom before retiring.

Western Malaria Mosquito (*Anopheles freeborni)*

Females feed mainly on medium to large mammals like rabbits, deer, cattle or horses, and they pursue and bite man aggressively.



Anopheles freeborni is the most important malaria vector in California. In our lifetime, endemic malaria has been eradicated from the U.S. But in our grandparents' time, it was so serious that education guidelines called for it to be included in the instructional program in every primary school.

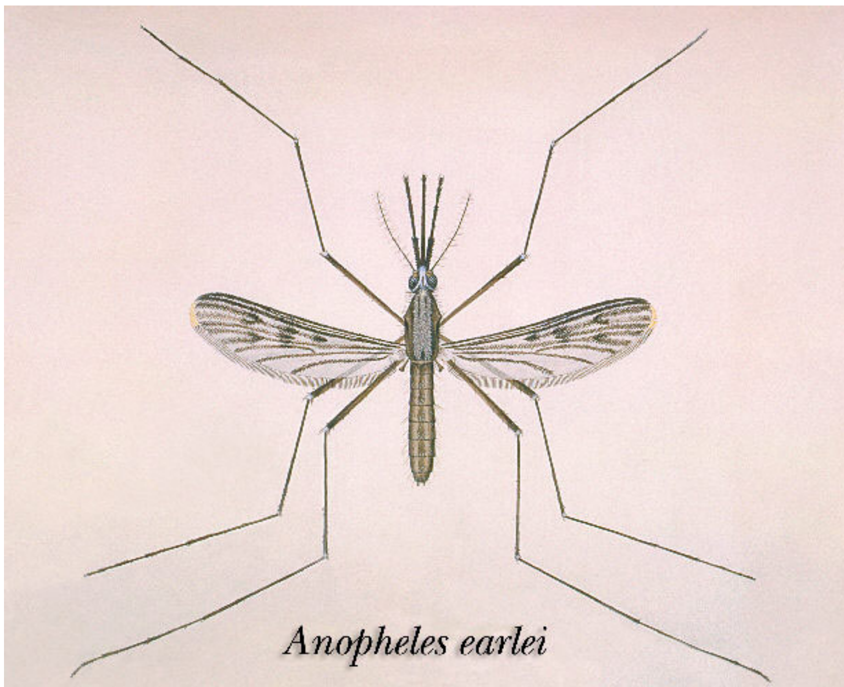
Today, carrier mosquitoes still occur throughout the state, and hundreds of active infections are discovered every year in tourists and immigrants from other countries.

Anopheles are easily distinguished from other mosquitoes: their eggs are laid individually and have small floats on each side; the larvae lack the long breathing tube found in other mosquitoes; adults have hairs, but no scales on the abdomen and both sexes have palpi as long as the proboscis. Feeding females assume a distinctive pose with their abdomen pointed high in the air.

Western malaria mosquitoes occur west of the Rocky Mountains, between southern Canada and northern Mexico, and from sea level to about 6,000 ft. elevation. The larvae prefer clear, clean water, in sunlit or partially shaded streams or ponds. They occur abundantly in both Marin and Sonoma counties, but their highest density is found in the irrigated and seasonally flooded rice fields of the great central valley, historically the region of California's highest malaria infection rates.

Adults migrate in the spring and fall, but most stay within five miles of their larval sites. Like most *Anopheles*, they are active during the hours of darkness, and find shelter in hidden places during the day. Females feed mainly on medium to large mammals like rabbits, deer, cattle or horses, and they pursue and bite man aggressively.

The blood feeding patterns of *Anopheles freeborni* Aitken and *Culex tarsalis* Coquillett were studied, and the effects of host availability on these patterns were assessed in four different habitats within a northern California rice agroecosystem. Resting mosquitoes were collected from June to September of 1991 and 1992. The source of mosquito blood meals was identified with the modified precipitin test.



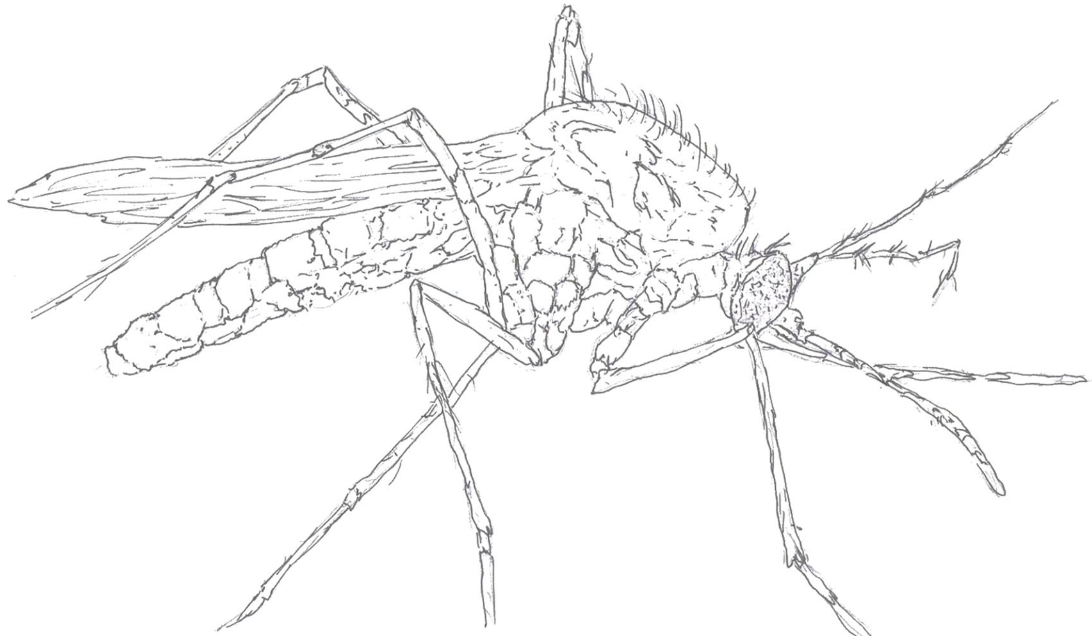
Anopheles freeborni exhibited a 'specialized' (fixed) blood feeding pattern, predominantly (99% of the time) feeding on mammalian hosts; leporids and bovids were the major hosts, while equines, suids, and other mammals were minor hosts. *Culex tarsalis* exhibited a more 'generalized' (catholic) blood feeding pattern, taking blood meals from both birds and mammals at a ratio of 3:1 with Passeriformes being the most fed upon host group.

Human blood indices were under 3% for both mosquito species, and multiple blood meals were estimated at less than 2%. The host feeding patterns for both mosquito species differed among the four (riparian, rice, pasture and mixed) habitats.

The host feeding pattern for *C. tarsalis* reflected the distribution of both mammalian and avian hosts available. On the contrary, the host feeding patterns for *A. freeborni* reflected the distribution of mammalian but not the available avian hosts. Overall, host availability may be an important determinant of population size of some mosquito taxa (e.g. *A. freeborni*) than others (e.g. *C. tarsalis*) in rice culture agroecosystems.

Western Treehole Mosquito (*Aedes sierrensis*)

Primary vector of Dog Heartworm disease in the Western United States.



WESTERN TREE-HOLE MOSQUITO
(Aedes sierrensis)

Aedes is the best represented mosquito genus in California in the number of species. Many species in this genus are commonly referred to as floodwater mosquitoes because eggs are laid in sources that will eventually fill with water. *Aedes* eggs are laid singly at the edge of drying substrate. They are resistant to drying out and may require a conditioning period before hatching. Larvae have a short siphon and hang downward at a 45-degree angle from the water surface. Adults have a pointed abdomen and rest with their bodies parallel to the surface. Most *Aedes* adults readily feed on humans and are aggressive biters. Several species are capable of transmitting diseases to humans including dengue, yellow fever, chikungunya, and many others. *Aedes sierrensis* is the primary vector of dog heartworm in California.

Twenty-seven *Aedes* species are recognized in California, one of which, *Ae. atropalpus*, has only been collected once near Folsom, CA. Two species, *Ae. albopictus* and *Ae. aegypti*, are not included in this total although they have been introduced into California several times. The most recent introductions occurred in 2011 (*Ae. albopictus*) and 2013 (*Ae. aegypti*). Efforts to eradicate these mosquitoes are ongoing.

The Western Treehole Mosquito (Aedes sierrensis) is brightly marked with white scales which contrast with its dark body. It also has an unbanded proboscis (beak), white banded tarsi (feet) and a pointed tipped abdomen. The Western Treehole Mosquito (Aedes sierrensis) received its name because the immature stages are frequently found in water contained in rot holes of trees such as oak, laurel, madrone, eucalyptus and other local species.

This mosquito is found in most California counties and is the primary vector of Dog Heartworm disease in the Western United States. Western Treehole Mosquitoes have four life stages: egg, larva, pupa, and adult. The immature stages need standing water to complete their life cycle.

Western Treehole Mosquitoes are a serious pest problem when they are present in large numbers. This mosquito is the primary vector of Dog Heartworm Disease in the coastal and foothill communities of California.

Wrigglers
After an adult female lays her eggs they hatch into larvae (wrigglers), which feed on small organic particles and microorganisms in the water. Feeding occurs when they hang from the water's surface by the tip of their tail (siphon) or by browsing along the bottom of their habitat. Because they are air breathing organisms they must return to the water's surface to breathe. Larval development varies from ten days to five months depending on weather conditions with developmental completion occurring around the spring equinox (late March). At the end of the larval stage, the mosquito molts and becomes the aquatic pupa (tumbler). The pupa is active only if disturbed, for this is the resting stage where the larval form is transformed into the adult. This can take four or more days during which time feeding does not occur. When the transformation is completed, the new adult splits the pupal skin and emerges.

Adult Daily Activity
Adults begin to emerge with the advent of the spring equinox, requiring a 12-hour day length to trigger emergence. Males tend to hover around potential hosts of the female, seizing her in flight when she approaches, to mate with her. Male mating swarms also occur in the shaded areas of this mosquito’s habitat. Adults can live up to several months depending on temperature, humidity and other climactic factors.
They are frequent pests in residential and recreational areas April through August where large numbers of trees are present.

Adult Flight Range: This mosquito has a limited flight range staying very close to its breeding site.

Adult Feeding: Adults feed predominantly on small mammals but will feed on large mammals and humans when available. Peak feeding activity occurs at dusk, although host feeding does sometimes occur during the day and night. Treehole Mosquitoes prefer to feed outdoors (but sometimes enter homes) during the mid-morning and late afternoon. Like all species of mosquitoes, only the female mosquito takes a blood meal (bites).

Eggs and Larvae: Eggs are laid individually inside moist treeholes, crotches of trees, and containers with damp leafy debris. Eggs usually hatch the next season following flooding with early winter rainfall. It should be noted that the eggs of this species can survive for many years before hatching, with only part of each batch hatching during a single season. Larval development can take ten days to five months to complete, depending on quantity of rainfall and other environmental conditions.

Dog Heartworm Disease
Dog Heartworm Disease is a clinical condition in dogs caused by a roundworm, Dirofilaria immitis, which resides within the dog’s heart and lungs. This disease, a serious and possibly fatal veterinary problem, is associated with dogs, coyotes and foxes. Canine Heartworm is transmitted by the bite of an infected Western Treehole Mosquito.
The adult worm lives in the right side of the heart and the adjacent large blood vessels and lungs, where it may attain a length of 6-12 inches. Many other mosquito species feed on dogs, but the Western Treehole Mosquito is the most common carrier of heartworm.

Disease Symptoms
The outward symptoms of the disease are not noticeable in most cases until reduced blood flow caused by adult worms damages the heart, lungs, liver and kidneys. Advanced symptoms of heartworm may include: rapid tiring, shortness of breath, chronic soft dry cough, listlessness and weight loss. If you live in or travel to areas where treehole mosquitoes occur, check with your veterinarian regarding treatment and prevention.

Drugs are available to prevent the disease, and it is curable if diagnosed in the early stages. The time of highest risk for dogs to contract heartworm is April through August; however, unseasonable rainfall may extend this period.

Where possible, the best approach is to prevent mosquitoes from breeding by eliminating or modifying breeding sites. This can be accomplished best by eliminating containers which are capable of holding water. Where breeding sites exist in standing or slow-moving water, corrective action to permanently eliminate them by such means as filling, pumping, ditching or draining is recommended.

Close coordination with your local mosquito abatement district and environmental regulatory authorities is recommended.

An important consideration in the practice of mosquito control is the advisability, whenever possible, to target control operations against immature populations. These stages are usually concentrated, relatively immobile and therefore occupy minimum acreage compared with adults, which may rapidly disperse over large areas.

By targeting the immatures, it is possible to minimize the area treated and often avoid treating populated areas. Conversely, targeting adult mosquitoes may require highly visible and extensive applications of adulticides within residential and urban areas.

The adulticides registered for this use are applied at levels 100 to 10,000 times below rates that would be cause for concern about exposure risk for the general public or the environment. Nevertheless, achieving good larval control while at the same time minimizing the use of adulticides is environmentally and client friendly, and appreciated by the public.

Most states have specific regulations governing the decision to apply pesticides for mosquito control. These usually involve the collection of data that substantiate the need for the application. Thus, standardized ultra-low-volume (ULV) operation on a fixed schedule is not allowed in most areas. Each application must be justified by documentation of increased mosquito activity, such as trap collections, landing or biting counts, telephone complaints, etc.

Winter Marsh Mosquito *(Culiseta inornata)*

Mosquito species that is a secondary or suspected vector of Western equine encephalitis and California group encephalitis within the U.S.

Culiseta is a genus of mosquitoes. Most Culiseta species are cold-adapted, and only occur in warmer climates during the colder parts of the year or at higher elevations where temperatures are lower.

Species found in Southern California are larger than most mosquito's species, specifically Cs. inornata, Cs. particeps, and Cs. incidens. These species are found throughout the year in Southern California and feed on several vertebrate species, such as birds, livestock, rodents, reptiles, and humans.

The larvae of most species are found bogs, marshes, ponds, streams, ditches, and rock pools, but an African species occurs in tree holes, a common eastern Palaearctic species occurs in water wells and rock pools, and several Australian species occur under ground. Little is known about the blood-feeding habits of females. Most species feed on birds and mammals, but a few feed on reptiles. Several species attack domestic animals and occasionally humans.

Winter Salt Marsh Mosquito *(Aedes squamiger)*
Major pest of humans.

The Winter Salt Marsh Mosquito *(Aedes squamiger)* is one of 53 types of mosquitoes that occur in California and is a distinctive black and white mosquito that breeds in California coastal pickle weed tidal and diked marshes. Salt marsh pools that are diluted by winter and early spring rains are especially favored breeding sites. Other sites include the cracked ground of diked wetlands and old dredge disposal sites. This species is a major pest of humans.

Winter Salt Marsh Mosquitoes are a serious pest problem when they are present in large numbers. California Encephalitis virus has been found in populations of this mosquito although transmission of this virus to humans has not yet been confirmed

Life Cycle
Winter Salt Marsh Mosquitoes have four life stages: egg, larva, pupa, and adult. The immature stages need standing water to complete their life cycle.

After an adult female lays her eggs they hatch into larvae (wrigglers), which feed on small organic particles and microorganisms in the water. Feeding occurs when they hang from the water's surface by the tip of their tail (siphon) or by browsing along the bottom of their habitat. Because they are air breathing organisms they must return to the water's surface to breathe.

Larval development varies from one to four months depending on weather conditions with developmental completion occurring near the end of February. At the end of the larval stage, the mosquito molts and becomes the aquatic pupa (tumbler). The pupa is active only if disturbed, for this is the resting stage where the larval form is transformed into the adult. This takes about two days during which time feeding does not occur. When the transformation is completed, the new adult splits the pupal skin and emerges.

Adult Daily Activity
Adults usually emerge during the last weeks of February through the end of March depending on the amount and timing of the preceding winter rains.
Adults usually fly to areas away from their breeding sites, using ravines and natural or man-made waterways from the marshes to the local hills as passage ways.

From these passage ways the adults spread laterally into the wind protected areas of the surrounding community. Adults then mate, with the females seeking a blood meal and returning to the marshes to lay their eggs. Mature mosquitoes can live as long as three months depending on temperature, humidity and other climactic factors.

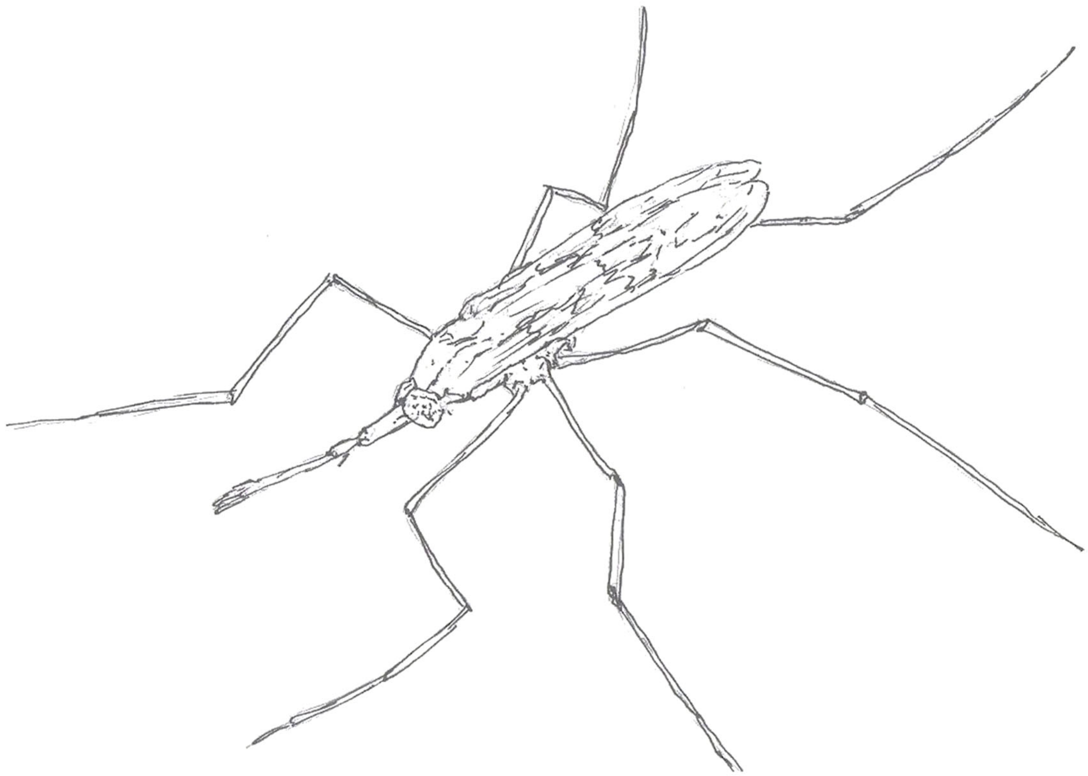
Adult Flight Range
This mosquito readily flies 10-20 miles from its breeding site.

Adult Feeding
Humans and possibly other large mammals are the preferred hosts for this mosquito. Biting activity occurs most often during the daylight hours and at dusk from April through June.

Eggs and Larvae
Eggs are laid on plants and along the muddy margins of ponds close to the water line awaiting submersion by the following years tides and/or rainfall. It should be noted that the eggs can remain viable for many years with only part of any one batch of laid eggs hatching during any single flooding event.

Woodland Malaria Mosquito (*Anopheles punctipennis*)

Aggressive biters and readily enter homes.



WOODLAND MALARIA MOSQUITO
(Anopheles punctipennis)

The wings have conspicuous pale and dark spots and palpi that are entirely dark. They are aggressive biters and readily enter homes.

Larval habitat: Woodland pools containing vegetation and in artificial containers and other environments associated with Culex tarsalis and Culex pipiens.
Biting time: Day and dusk
Preferred host: large mammals including cows, horses, and human
Flight range: 0 to ¼ mile from breeding site

Woodland Malaria Mosquitoes have four life stages: egg, larva, pupa, and adult. The immature stages need standing water to complete their life cycle. After an adult female lays her eggs they hatch into larvae (wrigglers), which feed on small organic particles and microorganisms in the water. Because they are air breathing organisms they must return to the water's surface to breathe.

About one to two weeks are required for larval development. At the end of the larval stage, the mosquito molts and becomes the aquatic pupa (tumbler). The pupa is active only if disturbed, for this is the resting stage where the larval form is transformed into the adult. This takes about two days during which time feeding does not occur.

When the transformation is completed, the new adult splits the pupal skin and emerges. Under optimum conditions, development from egg to adult takes about three weeks.

However, all mosquito developmental times are dependent on the temperature and nutrients of the water in which they mature.

Where possible, the best approach is to prevent mosquitoes from breeding by modifying their breeding sites. Careful planning and coordinated efforts with landowners, regulatory agencies and concerned citizens is essential for any creek or stream enhancement project.

Where possible, the best approach is to prevent mosquitoes from breeding by eliminating or modifying breeding sites. This can be accomplished best by eliminating containers which are capable of holding water. Where breeding sites exist in standing or slow-moving water, corrective action to permanently eliminate them by such means as filling, pumping, ditching or draining is recommended. Close coordination with your local mosquito abatement district and environmental regulatory authorities is recommended.

Mosquito Repellents

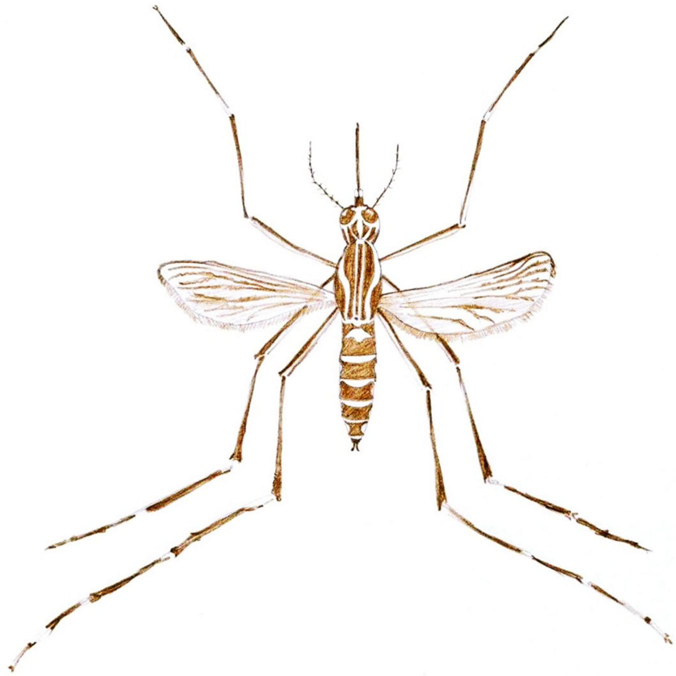
The CDC traveler's page on preventing dengue fever suggests using mosquito repellents that contain DEET (N, N-diethylmetatoluamide, between 20% to 30% concentration, but not more). It also suggests the following:

1. The mosquito usually bites at dusk and dawn but may bite at any time during the day – especially indoors, in shady areas, or when the weather is cloudy.
2. The mosquito's preferred breeding areas are in areas of stagnant water, such as flower vases, uncovered barrels, buckets, and discarded tires, but the most dangerous areas are wet shower floors and toilet tanks, as they allow the mosquitos to breed in the residence. Research has shown that certain chemicals emanating from bacteria in water containers stimulate the female mosquitoes to lay their eggs. They are particularly motivated to lay eggs in water containers that have the correct amounts of specific fatty acids associated with bacteria involved in the degradation of leaves and other organic matter in water. The chemicals associated with the microbial stew are far more stimulating to discerning female mosquitoes than plain or filtered water in which the bacteria once lived.
3. Wear long-sleeved clothing and long trousers when outdoors during the day and evening.
4. Spray permethrin or DEET repellents on clothing, as mosquitos may bite through thin clothing.
5. Use mosquito netting over the bed if the bedroom is not air conditioned or screened. For additional protection, treat the mosquito netting with the insecticide permethrin.
6. Spray permethrin or a similar insecticide in the bedroom before retiring.

Yellow Fever Mosquito (*Aedes aegypti*)

Roland Mortimer, Rio de Janeiro

Many people have died from Dengue fever and many more around the world suffer terribly because of this species.



The yellow fever mosquito belongs to the tribe Aedini of the dipteran family Culicidae and to the genus Aedes and subgenus Stegomyia. According to the recent analyses, some authors raised the subgenus Stegomyia of the genus Aedes to the level of genus. The proposed name change has not been completely accepted; at least one scientific journal, the Journal of Medical Entomology, has officially encouraged authors dealing with aedine mosquitoes to continue to use the traditional names. Although the lifespan of an adult Aedes aegypti is between two to four weeks depending on conditions. Aedes aegypti's eggs can be viable for over a year in a dry state, which allows the mosquito to re-emerge after a cold winter or dry spell.

The yellow fever mosquito (Aedes aegypti) genome is being sequenced by The Broad Institute and The Institute for Genomic Research (TIGR). The initial assembly was released in August 2005; a draft sequence of the genome and preliminary analysis was published in June 2007. Annotation of the sequence is being undertaken by VectorBase and TIGR. Aedes aegypti is a vector for transmitting several tropical fevers.

Only the female bites for blood which she needs to mature her eggs. Understanding how the mosquito detects its host is a crucial step in the spread of the disease. Aedes aegypti are attracted to chemical compounds that are emitted by mammals. These compounds include ammonia, carbon dioxide, lactic acid, and octenol.

Scientists at the Agricultural Research Service have studied the specific chemical structure of octenol in order to better understand why this chemical attracts the mosquito to its host. They found that the mosquito has a preference for “right-handed” (dextrorotatory) octenol molecules. The term “right-handed” refers to the specific orientation of the molecule, which can either be “right-handed” or “left –handed.” This discovery helps scientists understand how the mosquito seeks out its host and may enable them to develop more effective forms of mosquito repellant.

There are many types of mosquitoes living in the tropical and sub-tropical regions of the world. We can roughly divide them into two groups--Culex and Aedes--but perhaps one of the most important is ***Aedes aegypti***. According to the World Health Organization, the virus for Dengue fever is the most important arbovirus to man in the world, and since *Aedes* has been found to transmit this virus, it has been widely studied and blamed as the vector.

This mosquito is small in comparison to others, usually between three to four millimeters in length, discounting leg length. It is totally black, apart from white '*spots*' on the body and head regions and white rings on the legs. The thorax is decorated with a white '*Lyre*' shape, of which the 'chords' are two dull yellow lines. Its wings are translucent and bordered with scales.

At rest, the insect turns up its hind legs in a curved fashion and usually cleans them by rubbing one against the other, or exercises them by crossing them and alternately raising and lowering them.

Many people believe mosquitoes only live two or three days, but in actual fact, left unmolested, they can live for months. The males of all species of mosquitoes do not bite humans or animals of any species, they live on fruit.

Only the female bites for blood, which she needs to mature her eggs. The eggs of most species are laid together in a raft form, but *Aedes* lays her eggs separately, thus allowing them to spread over large surfaces of water if conditions permit. In this way, the eggs stand a better chance of survival. When freshly laid, the eggs are white, but soon turn black in color. The young larvae feed on bacteria in the water and soon cast their skins as they rapidly grow. Most types of mosquito species can lay their eggs in any type of water, mainly dirty or even polluted. Not *Aedes*, she only lays her eggs in clean water which contains no other living species.

Many people have died from Dengue fever and many more around the world suffer terribly because of this species. The male mosquito is much more beautiful. His antennae looking like large plumes and the palpi long and adorned with feathery hairs. After a few weeks, or even shorter in the summer, the larvae reach the pupa stage. This stage is usually very short, and the pupae rise to the surface of the water, where the top of the pupal case opens, like the lid on a can, and out emerges the new adult.

Aedes aegypti, unlike other species, is very intelligent, if one could say that mosquitoes are intelligent. They arrived in Brazil from Ethiopia with the slave trading ships. Living near man for so long she has become totally dependent on him and has learned a lot from him. For instance, she has greatly reduced the `humming' sound she makes with her wings so man cannot hear it, unlike other species whose humming is extremely irritating and awakens the deepest sleeper.

She never lives more than ninety meters from dwellings, thus guaranteeing her meals. She attacks from below or behind, usually from underneath desks or chairs and mainly at the feet and ankles. The insect is very fast in flight, unless gorged with blood. Other types of mosquitoes even fly into your face and can be easily caught or killed--not *Aedes*, she's too smart!

The eggs can survive for very long periods in a dry state, often for more than a year. Since the virus can be passed from adult to egg, the virus, too, is guaranteed survival until the next summer and heavy rains.

Mosquito Surveillance and Monitoring Sub-Section

Effective Mosquito-Control Program
Surveys are essential for the planning, operation and evaluation of an effective mosquito-control program, whether for the prevention of mosquito-borne diseases or to reduce mosquito populations to levels permitting normal activities without undue discomfort. Initial surveys identify the species of mosquitoes present and provide general information on locations, densities and disease potential. With this knowledge it may be possible to determine life cycles and feeding preferences; predict larval habitats, adult resting places and flight ranges; and perhaps even make preliminary recommendations for control programs.

Basic Inspection Program
The next step is to embark on a formal surveillance program in which routine monitoring of mosquito presence is conducted. A basic inspection program usually addresses adult and larval population density and species composition, rainfall and tide monitoring, and breeding site locations. Additional specialized surveillance may be conducted to detect arboviral presence in birds and mosquito populations, operation of ovitraps (e.g., for Ae. aegypti and Ae. albopictus surveillance), or sampling of floodwater mosquito eggs to locate breeding sites. This information not only provides justification for source reduction and insecticide applications, but it also serves as an ongoing indicator of the effectiveness of these activities and continually adds to the database of knowledge concerning mosquitoes in the area. Such inspections do not determine the absolute population of mosquitoes, but they can show fluctuations in relative mosquito abundance and diversity over time in the various habitats visited.

Mosquito Mapping
Reasonably accurate and comprehensive maps are essential in conducting a mosquito-control operation. Maps provide information for field survey and control activities, program evaluation, and reporting and budgeting purposes. They show elevations, streets, roads and railroads, as well as ponds, lakes, streams, sewage lagoons, flooded woodlots and other breeding areas. They are used for orientation and for locating and plotting larval breeding places and adult sampling stations.

When large areas are involved, a master map may be needed for planning drainage and other field operations. The master map will indicate the treatment areas, the possible flight range of mosquitoes from breeding sites and the potential degree of penetration into populated areas. Larval and adult sampling stations can be indicated by symbols and numbers. Counts made at these stations at weekly or biweekly intervals provide information for current evaluation of the mosquito problem at any time by indicating the abundance of mosquitoes, species involved, flight range and habitat, and disease potential. This information identifies areas requiring high priority for treatment.

Narrative descriptions, sometimes necessary for exact location description, are simplified whenever possible. For example, "N.W. corner of 15th Street and Ninth Avenue" is a brief description that leaves no doubt as to the location. There may be some areas that are difficult to accurately locate (e.g., marshlands). However, maps can be subdivided into numbered or named areas for easy reference, and Global Positioning System (GPS) coordinates are very reliable.

Some common methods of subdividing maps involve the use of geographical features, artificial grids or a combination of both to set boundaries on areas that are indexed for easy reference and filing.

To avoid cluttering, the larger areas may be further subdivided by the use of transparent overlays, again employing geographical features or a grid. Once the area of inspection is delineated by reference to index numbers, additional location data can be conveyed clearly by the use of cards that include a rough sketch of the area or incorporated into a Geographic Information System (GIS) format.

Mosquito Record-keeping
In order to avoid comparing dissimilar parameters, inspections should be consistent both in method and location. Keeping clear, accurate records is as important as the data gathering itself.

Surveillance records are managed in a manner that ensures subsequent inspections can be conducted in a similar manner by others less familiar with the area. They usually include the inspector's name, date of inspection and exact location in addition to the data collected. Data-recording forms and devices promote uniformity, which makes records easier to read, interpret and summarize, and serve as a reminder to the inspector to record all pertinent information. In the absence of data recorders, standardized formats lead to more consistently accurate transcription of the data into the permanent records.

Mosquito Egg Surveys
Egg surveys are carried out primarily to determine the exact breeding locations of mosquitoes. Aedes, Ochlerotatus and Psorophora mosquitoes lay their eggs on damp soil in places subject to intermittent flooding. Two types of egg surveys may be conducted for these genera: sod sampling and egg separation.

Sod Sampling
Sod samples, usually containing 8 cubic inches of soil and vegetation with a thickness of about an inch, are stored for a week or more to allow the embryos time to develop within the eggs. The sod samples are then placed in glass jars and flooded with water. The larvae are identified after they hatch.

Several sequential floodings and dryings might be necessary to get sufficient cumulative hatch. In larval surveys, sod sampling delineates breeding areas, especially when sampling is done during times when larvae are not present.

Egg Separation
Egg separation machines can be used for separating mosquito eggs from soil and debris by mechanical agitation, washing, screening, or sedimentation of debris and flotation of the eggs in a saturated salt solution. Sod or soil samples are cut in the field with a sharp trowel around a 6-inch-square template, placed in plastic bags and stored (sometimes for months) in a cool room.

The various species and densities of Aedes, Ochlerotatus and Psorophora can be identified by microscopic examination of live or preserved eggs using taxonomic keys for mosquito eggs.

Mosquito traps recreate warm moist CO_2 (human breath), primarily with dry ice but other traps use propane, and some traps add the irresistible attraction of octenol to trap mosquitoes. Some traps will contain a suction fan and a light bulb to trap and attract the female mosquito. Several mosquito traps will operate quietly and will eliminate hundreds of mosquitoes in a few hours at dusk and dawn.

Several government agencies will place the daily quarry of mosquitoes into plastic bags for counting and determining the mosquito species. The captured mosquitoes are often sent to a laboratory for further analysis.

Oviposition Trap
Collections of mosquito eggs in oviposition traps are used to detect and monitor container-breeding mosquitoes such as Oc. triseriatus, Ae. aegypti and Ae. albopictus. The oviposition trap can easily be made out of food cans (3-pound coffee cans) or pint jars painted black inside and outside. The traps are placed in shaded areas at a height no greater than 1.2 m and filled with water and a few dried leaves placed at the bottom of the container. An oviposition substrate made of a strip of various materials (seed germination paper, muslin, formica, balsa wood, wooden tongue depressor, etc.) is then placed vertically inside the container with the water covering about half of it.

Gravid females use this substrate to lay eggs just above the water level. Traps are checked every 10 to 14 days to prevent them from becoming breeding sources. If larvae are found in the trap, then the water should be dumped and the trap reset. The ovipositional substrate is periodically collected and returned to the laboratory in a plastic bag. Samples are kept cool and moist during transportation, taking care to avoid too much moisture, which could cause eggs to begin hatching. Eggs or the resulting 4th instar larvae are then identified.

Larval and Pupal Surveillance
Before beginning a survey, obtain information about the general breeding behavior and habitats of the species known or suspected to be in the area. An experienced person may be able to spot the probable mosquito breeding places in a specific area by rapid reconnaissance. These areas are carefully numbered and marked on the map. Determining the specific breeding sites and establishing permanent larval sampling stations requires a more detailed inspection. Larval surveys to determine the exact areas in which the mosquitoes breed and their relative abundance are of special value in control operations.

Equipment
A white enameled or plastic dipper about 4 inches in diameter (1 pint or 350 ml capacity) is frequently used for collecting mosquito larvae. The handle of the dipper may be lengthened by inserting a suitable piece of wood dowel or PVC pipe. Specially designed dippers can be created so that their capacity can be directly related to the amount of water surface examined. Thus, the number of larvae per square foot or meter can be computed with reasonable accuracy.

Dip Procedure
Mosquito larvae of some species are usually found near surface vegetation or debris. In larger ponds or bodies of water, these larvae are ordinarily confined to the shoreline areas where it is necessary to proceed slowly and carefully in searching for mosquito larvae as disturbance of the water or shadows may cause the larvae to dive to the bottom.

Anopheline larvae are collected by a skimming movement of the dipper with one side pressed just below the surface. The stroke is ended just before the dipper is full because larvae will be lost if the dipper is filled to the point that it runs over. Where clumps of erect vegetation are present, it is best to press the dipper into a clump with one edge depressed so that the water flows from the vegetation into the dipper. Culicine larvae such as Ae. vexans or Oc. sollicitans or species of Psorophora require a quicker chopping motion of the dipper as they are more likely to dive below the surface when disturbed.

The inspector records the number of dips made and the number of larvae found, by instar if warranted, and transfers representative sample specimens by pipette into small vials of alcohol for later identification. With most species, it is possible to get a rough idea of the breeding activity by computing the average number of larvae of each species per dip.

The number of dips required will depend on the size of the area and the relative larval density, but for convenience is often in multiples of 10. Inspection should be made at weekly or biweekly intervals during the mosquito breeding season, as areas that are entirely negative at one time may rapidly become heavily infested. Inspections for certain species require variations in the procedure described above.

For example, Coquillettidia larvae remain below the surface throughout much of their development attached by the siphon to the stems of emergent vegetation. These larvae are found by pulling up aquatic plants (cattail, sedges, pickerelweed, etc.), washing or shaking them in a pan of water, and searching the bottom muck and debris.

Inspection for Oc. triseriatus, Oc. sierrensis, etc., breeding involves searching tree holes and artificial containers such as tires. These containers are often too small for an ordinary dipper, but water can be transferred with a turkey baster or siphoned into a dipper or pan where the larvae can be seen.

Mosquito Identification Section Post Quiz

1. The black-tailed mosquito, *Culiseta melanura*, belongs to the family Culicidae. This species of mosquito is considered unusual because it overwinters as larvae while most mosquito species overwinter as either?

2. Culiseta melanura is important because of its role in the transmission cycle of?

3. Adult female *Culiseta melanura* primarily take blood meals from birds such as the?

4. Anopheles quadrimaculatus Say is historically not a vector of malaria in the eastern United States.
True of False

5. Malaria was never a serious plague in the United States.
True or False

6. Culex pipiens, the Northern House Mosquito has a distribution range along the Pacific coast extends into northern California and then east on a relatively straight line to North Carolina.
True or False

7. Culex pipiens females pass the winter in diapause and do not become active during periods of warm winter weather. Hibernating females are common in basements, outbuildings, and subterranean enclosures.
True or False

St. Louis Encephalitis

8. House Sparrows, an introduced species, circulate exceptionally high levels of SLE when they become infected. Culex pipiens that bite infected birds acquire the virus and are capable of passing it on to humans.
True or False

9. As mosquitoes go, the Western Encephalitis Mosquito is one of the more difficult to recognizable, because of its undistinctive scale patterns.
True or False

10. Species in the genus *Culex* are known as “standing-water” mosquitoes. Unlike their “floodwater” relatives (such as *Aedes vexans*) that lay eggs above the water line, standing-water mosquitoes must lay their eggs directly on the water’s surface.
True or False

Post Quiz Answers
1. Adults or eggs 2. Eastern equine encephalitis virus and potentially West Nile virus, 3. American robin, wood thrush, and gray catbird, 4. False, 5. False, 6. True, 7. True, 8. True, 9. False, 10. True

Topic 6 – Wood Destroyers -Termite Introduction

Section Focus: You will learn the basics of wood destroyers with an emphasis on termites, including the life cycle, behavior and related scientific information. At the end of this section, you the student will be able to understand and describe general information about the various wood destroyers including termites, including the life cycle and related information. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Termites are highly designed creatures that date back to the time of the dinosaurs. They are known as "silent destroyers" because of their ability to chew through wood, flooring and even wallpaper undetected. Each year, termites cause $5 billion in property damage - costs that aren't covered by homeowners' insurance policies. This is why being vigilant about termite control and termite extermination is so important.

Termite Introduction

In the US, we primarily have four species of termites, Subterranean (Subs), Drywood, Dampwood and Formosan (FST). Formosan are a new invasive species. We will examine these species, ants and other wood destroyers in detail.

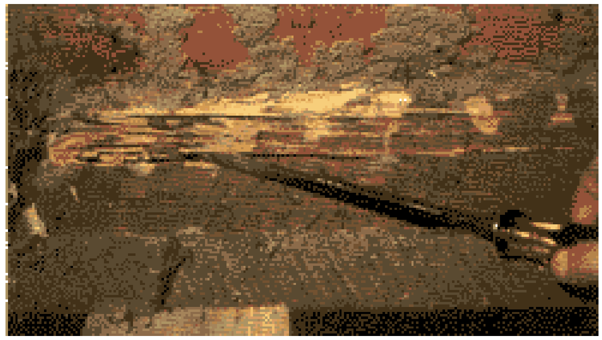
There are about 2,500 termite species in the world. North America has 42 different termite species, most of these are located in the southeast USA. Alaska is the only state without termites. Incredibly, Florida's eastern subterranean termite colonies have about 250,000 members, but can have 1 million or more.

An average termite colony eats about 1 cubic foot of wood a year. That amount may seem small, but generally speaking, homeowners are unaware of damage for many years. The termite queen can lay up to 2,000 eggs per day and live as long as 50 years.

Termite damage to residential and commercial buildings in the U.S. costs more than $1 billion annually. This amount does not include the cost of termite control. Subterranean termites, the most destructive of all termite species, account for 95% of the damage.

Two subterranean termite species, Reticulitermes flavipes (reference Kollar) and R. tibialis Banks, are commonly found in United States. Control of these termites' costs more than $5 million each year and is the reason you are studying this course. This CEU course focus is for you to master termite management/control/inspection/identification methods.

Subterranean(Subs) worker termite. Subterranean termites' mudtube (on glass surface).



Using a screwdriver to probe and examine termite damage, Subs will go with the grain.

Feeding Habits

Termites feed primarily on wood and wood products containing cellulose. Termites have special protozoa (microorganisms) in their intestine that provides enzymes to digest cellulose. This relationship is beneficial to both species, since the protozoans cause no harm and are provided with food and a protected environment by the termites. There is no way that these insects can live without these protozoa, and no way for these bacteria to survive without the termites.

Although termites are soft-bodied insects, their hard, saw-toothed jaws work like shears and can bite off extremely small fragments of wood. Termites often infest buildings and cause damage to lumber, wood panels, flooring, sheetrock, wallpaper, plastics, paper products, and fabric made of plant fibers. Termites attack flooring, carpeting, artwork, books, clothing, and furniture. The most serious damage involves the loss of structural strength. Most termites do not attack live trees, except for the Formosan and Dampwood termite. Dampwood prefer to feed on live trees – but wood that is under ground level notably citrus.

General Colony Information

There are two basic concepts of were the colony is located. Most of the time and for most of the termite species the colony is below ground.

Below Ground Termite Colonies

Subterranean termites are ground-dwelling social insects living in colonies. The two species of Subs found in United States have similar habitats. These termites have the ability to adjust the depth of their colony (nest) in soil depending on temperature and moisture requirements. The colony may be up to 18-20 feet deep in the ground. The ground serves as a protection against extreme temperatures and provides a moisture reservoir. Termites reach wood or cellulose materials above ground by constructing and traveling through earthen (mud) tubes. It takes about 4 to 5 years for a colony to reach its maximum size and it may consist of 60,000 to 200,000 workers.

Above Ground Termite Colonies

Drywood termites do not need a connection to soil and there is no soil in their feeding galleries. They do not build mud tunnels; they construct large, irregular galleries that run across and with the wood grain, with a very smooth, clean, and sandpaper-like appearance. The galleries are connected by openings small enough for one termite to pass through. The sure sign of drywood termite feeding is their fecal pellets that are ejected from the galleries via kick-out holes, often found right below the damaged wood. These pellets are quite unique and are hard, elongated-ovals with rounded ends, and have six concave sides.

We will cover this area more in detail in the inspection portion of the course.

Caste Definition
A group of insects with a specific morphology and function within a colony of social insects.

Most termite species have four castes, King and Queen (reproductives), Soldiers, Workers and Nymphs. There is an exception to this system; the Nevada dampwood termites have three primary castes: nymphs, reproductives and soldiers.

Reproduction
Generally speaking, there are minor differences with the species, in spring and fall, the winged males and females emerge from their parent colonies to form new ones. This activity is called swarming. These winged reproductives are dark brown to brownish black and have two pair of nearly equal size semitransparent wings extending well beyond the body.

The swarmers are weak flyers and, unless aided by wind, fly only short distances. Many of them are devoured by birds, spiders, ants, and other predators.

Survivors return to the ground and shed their wings. The wingless males and females pair off (male following female in tandem) until they find a source of wood and moisture in the soil. They dig soil near wood, enter the chamber and seal the opening. After mating, the queen begins laying eggs. The royal queen is known to survive up to 50 years in some termite species and others up to an average life span of 25 years. We will cover this later in the different species differences.

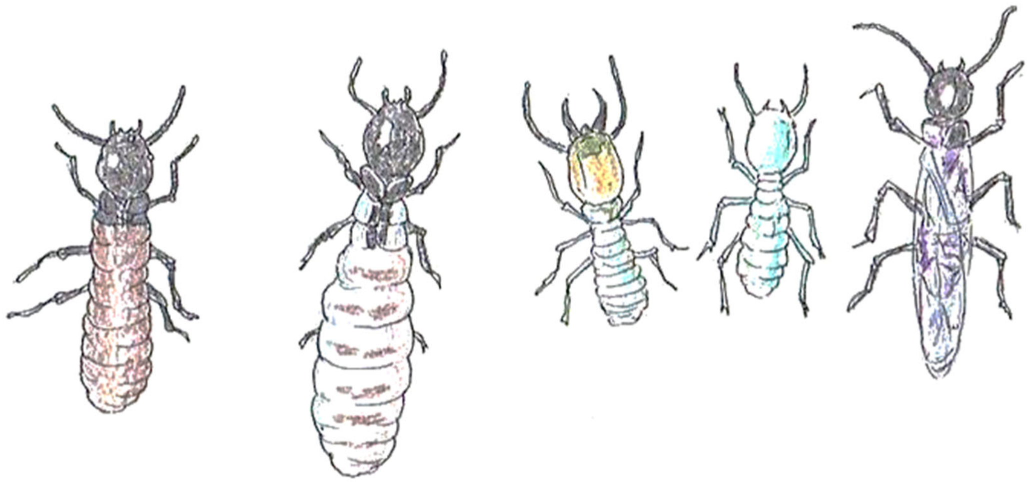
Eggs
Generally speaking, the fertilized Sub female (queen) usually deposits 6 to 20 eggs during the first six months following the swarming flight and she may lay more than 60,000 eggs in her lifetime. Eggs are yellowish white and hatch after an incubation period of 50 to 60 days.

Workers
The first broods of newly hatched nymphs (young termites) generally develop into workers. Full-grown workers are soft-bodied, wingless, blind, and creamy white. In early stages, they are fed predigested food by the king and queen. This first feeding also provides the bacteria to help these creatures digest their food. Once workers are able to digest wood, they begin providing food for the entire colony. At this time, the king and queen cease feeding on wood. The workers undertake all the labor in the colony such as obtaining food, feeding other caste members and immatures, excavating wood for chambers, and constructing tunnels. Workers mature within a year and live from 3 to 5 years.

Soldiers
Generally speaking, there are minor differences with the species Soldiers are creamy white, soft-bodied, wingless, and blind. The head of the soldier is enormously elongated, brownish, hard, and equipped with two strong jaws. Soldiers must be fed by workers as they are incapable of feeding themselves. They are less numerous than workers and their sole function is to defend the colony against invaders such as ants. Soldiers mature within a year and live up to 5 years.

Sub Soldier

Flying ants and swarming termites are often difficult to distinguish when these insects are seen around residential and commercial buildings. The main enemy of termites are Ants and the Soldiers can defend against a small number of Ants.



MALE REPRODUCTIVE   FEMALE REPRODUCTIVE   SOLDIER   WORKER   WINGED REPRODUCTIVE

TERMITE CASTES

Differences Between Ants and Termites

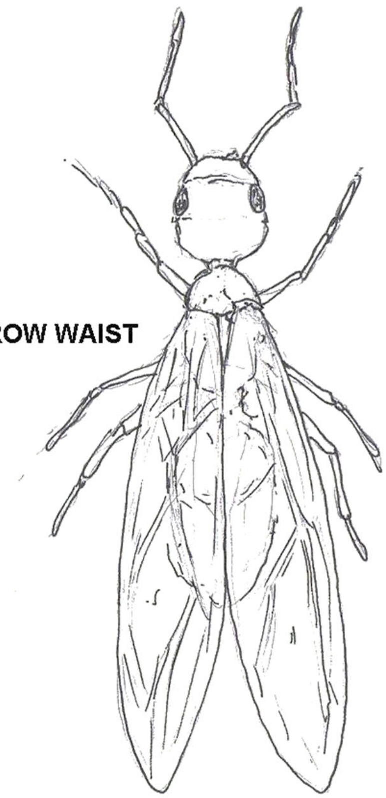
Body shape: A termite has no "waist," instead, its body is more rectangular, without any narrowing in the center. In contrast, the carpenter ant has a very well-defined narrow, constricted waist.

Antennae: An insect's feelers can say a lot about the insect, too. A termite has straight, beaded antennae, meanwhile, a carpenter ant's antennae are bent or "elbowed."

Wings: Both insects are winged creatures and each has four wings. A termite has wings that are of equal size and shape and its wings are much longer than its body. A carpenter ant's back, hind wings are shorter than its front forewings and the wings do not look unusually long or disproportionate to its body. Another thing with termites is that their wings are not as durable as ants. The wings of the termite fall off easily. The loose wings can often be seen near the opening of a termite nest and can be used to identify a termite infestation.

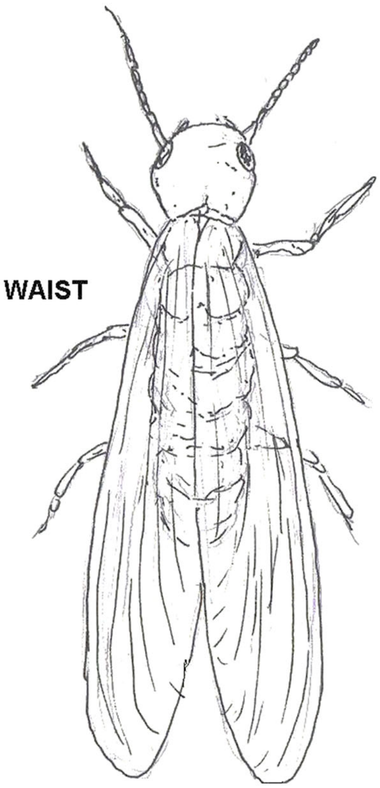
Color: Ant workers are reddish or dark-colored and are frequently seen in the open foraging for food. Termite workers, by comparison, are transparent, light or creamy white in color, and they avoid light. Termites are rarely noticed unless their nest is disturbed.

Characteristics	Ants	Termites
Active Reproductives	Queen(s)	Queen and Kings
Antennae	Bent or "elbowed	Straight, beaded
Wings	Hind wings are shorter than its front forewings	Equal size and shape
Parthenogenesis	All Species	Never
Larval Stage	Yes	No
Eye Sight	Most Species	Workers are blind
Build Earthen "Ant Nest"	Rarely	Most Species
Carnivorous	Most Species	Very few species
Grow Fungus "Gardens"	Very few Species	Most Species



WINGED ANT

FRONT WINGS LONGER THAN BACK
(1/2 inch IN SIZE)



WINGED TERMITE

BOTH PAIRS OF WINGS SAME SIZE
(1/2 inch IN SIZE)

Termite Life and Reproduction

More on Reproduction

The female (queen or winged reproductive) assumes a "*calling*" position with her abdomen elevated at a right angle to the rest of her body. She releases a chemical messenger (pheromone) which attracts nearby males. Once a male encounters a calling female, she moves off. He follows close behind and they search for a suitable site for the establishment of a nest. As soon as the pair has located a suitable site, they excavate (with their jaws) a small chamber large enough for the two of them and then seal the entrance. Mating usually occurs within a few hours to weeks after the pair becomes established.

The single female cannot start a new colony on her own, as some ants are able to do. Establishment of a termite colony is dependent upon the survival of both sexes in the nest site and that she has successfully mated. The pair continues to live together for life, and they usually mate periodically. The first eggs are laid within one to several weeks after mating, depending on the nutrition available to the female. When the first eggs hatch, the new nymphs are cared for by the young pair. After two molts, the nymphs assume their role as workers and begin to feed and care for the original pair.

Development of the Colony

Development of the colony is very slow for several years. Eggs are not deposited continuously. After the first group of eggs has been laid, there is a period of several months before another group is laid. This process continues for several years. As the young queen matures, she lays a greater number of eggs, and her abdomen becomes enlarged from developing eggs. Eventually, a point is reached where the colony size stabilizes. That is, the queen has reached maximum egg production, and the loss of older individuals by death or swarming is approximately the same as the number of new individuals produced each year.

As the colony becomes mature, a greater number of swarmers are produced each year. It requires a minimum of 3 to 4 years--and as much as 8 to 10 years--for a colony of our native subterranean termites to become large enough and strong enough to start dispersal flights.

Swarming

When swarming occurs in a relatively new structure, it is because it was built over or near a strong colony that was not severely damaged during the construction process. Termites derive food from wood and other cellulosic materials. Again as earlier, in nature, they feed exclusively on wood, primarily digesting out the cellulose and passing most of the remaining components as waste.

In man-invaded environments, termites attack many additional products and commodities. They still depend primarily on cellulose for their nutrition, but will damage many materials they encounter. Damaged materials may include plastics, rubber, asphalt, metal, mortar and others. Wood products like paper are favorite foods of termites because they are nearly pure cellulose. Cotton, burlap and other plant fibers are actively consumed by termites as well.

Fungi

Fungi also play a primary role in termite nutrition. Certain wood decay fungi are highly attractive to termites. Partially decayed wood is more easily digested by termites, and the fungus provides a needed source of nitrogen. Ultimately, wood-destroying fungi exhaust the nutritive value of wood for termites, and extensive decay in wood is of no benefit to foraging termites. Conversely, when termites attack wood, they usually bring fungus spores on their bodies. When water or other liquid reaches the damaged wood, it is more easily trapped.

Moisture
Moisture is vital to the survival of termites. Subterranean termites obtain most of their moisture from the soil. They maintain contact with the soil in order to survive. The type of soil has a great effect on the ability of subterranean termites to flourish. They generally prefer sandy soil over a clay base. They can and do survive in many other types of soil, however.

Tolerances
Generally speaking, most termite species have very little tolerance to dry conditions, or extremes of hot and cold. But they often must forage far, sometimes above ground, from their initial workings to find food. They move underground through tunnels. Whenever the termites leave the confines of the soil or the wood in which they are feeding, they construct shelter tubes in which to move from the soil to the wood or the above-ground nest.

Subterranean Termites
When subterranean termites invade the wood of a structure that is separated from the soil by intervening concrete, masonry or other impervious material, they construct shelter tubes (mud tubes) over the surface to the wood. Periodically, they return to the moist galleries. Contrary to published reports, shelter tubes do not necessarily conduct moist air from the soil to the wood.

Shelter tubes also provide some protection from air movement and prevent excess water loss. The primary function of shelter tubes probably is protection from natural enemies. Once termites have established contact with wood above ground and feeding progresses some distance from the initial shelter tunnel, they often will drop shelter tubes straight down from the wood. Evidence of tube building will be found directly below a suspended tube.

Castles
Under certain conditions, a fourth type of tube is constructed. Called swarming tubes or swarming "*castles*" they are constructed as flight platforms for swarmers and they have many turret-like projects and flattened horizontal branches that vaguely resemble castle towers. They usually are constructed on the ground to a height of 4 to 8 inches, but sometimes are found projecting from heavily infested wood above ground.

When swarmers are leaving the colony via these tubes, or directly through a hole in wood or soil, the openings are heavily guarded by soldiers and workers. The amount of damage that an infestation of subterranean termites might inflict on a structure depends on many factors. The number and size of the attacking colonies and the quality of the environmental conditions (including the wood) are the most important.

Damage usually starts at the mudsill in houses built over a crawl space and with the sole plates of those houses built on concrete slabs. Given enough time, subterranean termites will extend the damage into the wooden floor members, the interior trim and furnishings, and into the walls up to the roof timbers.

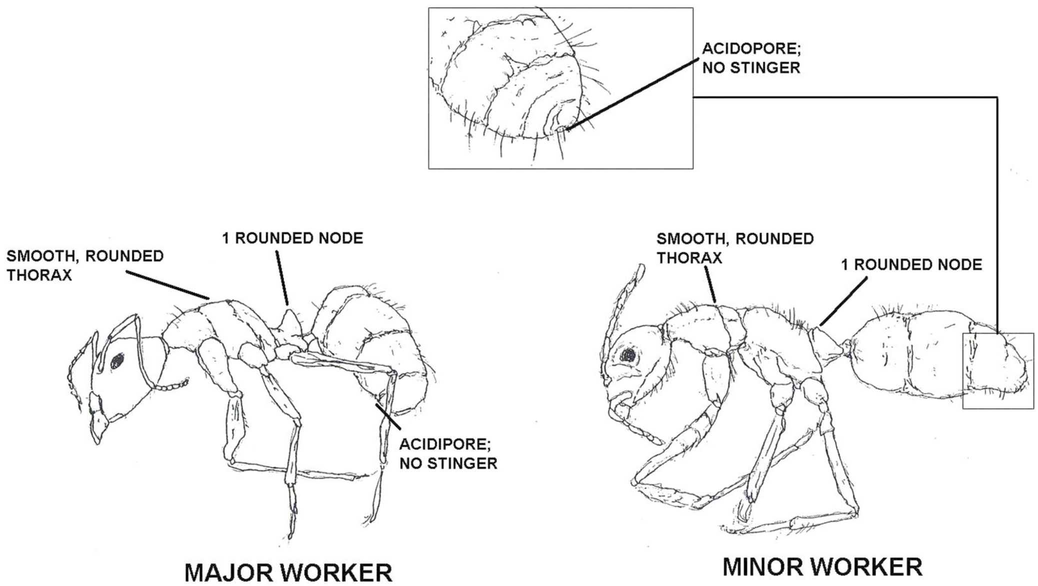
Damage
Severe damage by subterranean termites is not likely to occur in the first 8 or 10 years after construction. If treatment is undertaken with the first evidence of infestation, very little serious structural damage is ever likely to occur. Houses should be carefully inspected at least once a year in all regions. This will allow detection before damage is a problem. Should *evidence of termites be found, there is no cause for extreme alarm or undue haste.* Treatment within 3 months is highly recommended.

Communication in the Colony
1. Termites primarily communicate via pheromones. Each colony develops its own characteristic odor. Any intruder is instantly recognized and an alarm pheromone is released that triggers the soldiers to attack the intruder. If a worker finds a new source of food, it recruits others to that food source by laying a chemical trail. The proportion of castes in the colony is also regulated chemically. Again, nymphs can develop into workers, soldiers, or reproductive adults, depending on colony needs.
2. Sound is another means of communication. Soldiers and workers can bang their heads against tunnel walls. The vibrations are perceived by other termites in the colony and serve to mobilize the colony to defend itself.
3. Mutual exchange of foods enhances recognition of colony members.

Winged dampwood termite Alate.

Winged "sub" Alate.

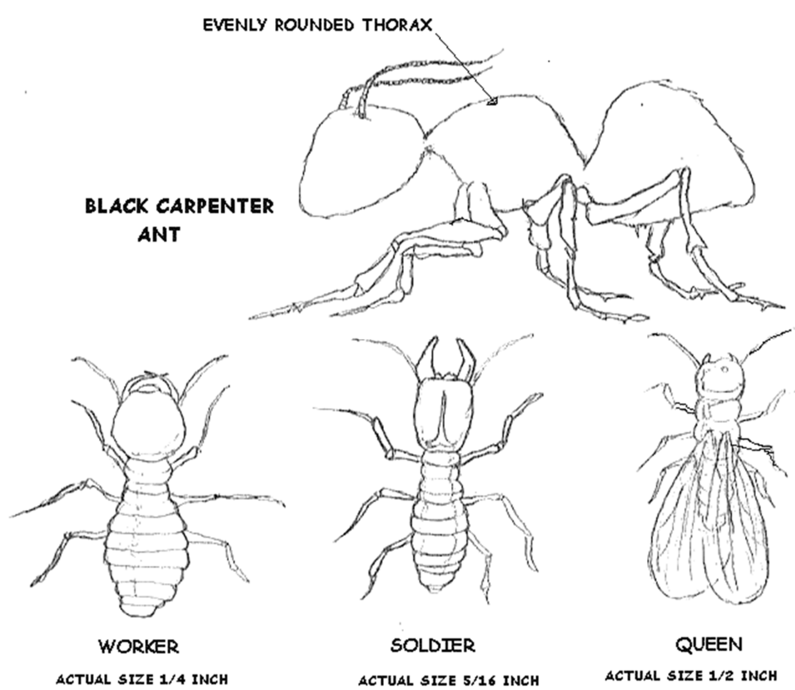
Termite gallery structure or what humans call “serious home damage”.

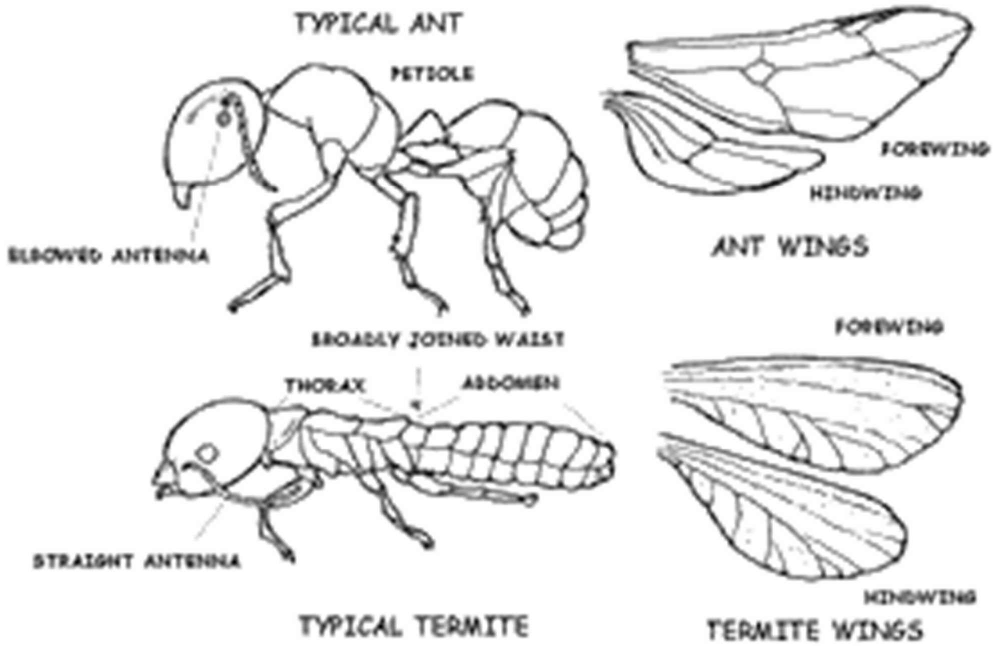


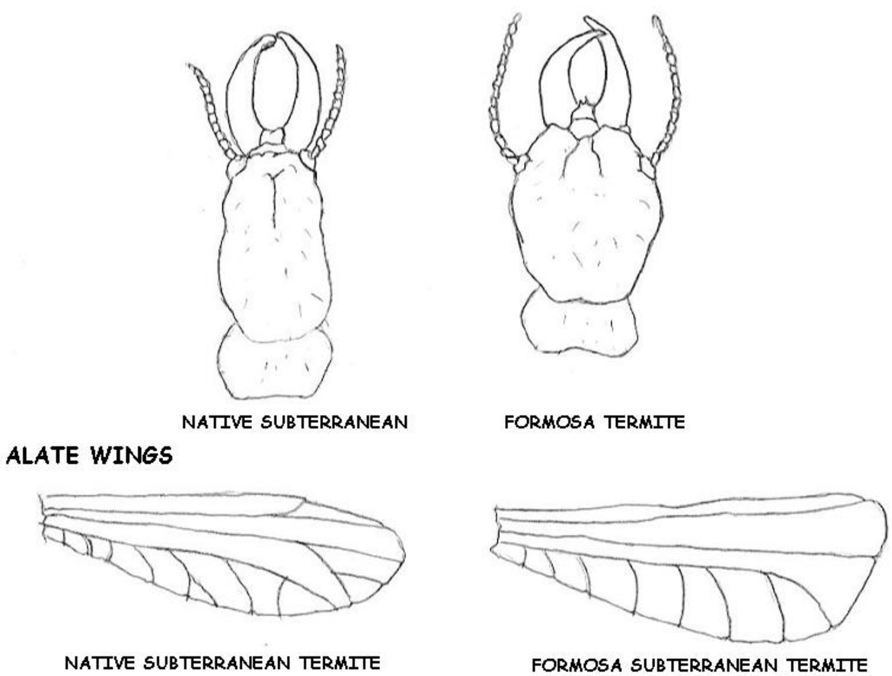
CARPENTER ANT

Carpenter Ant Identification

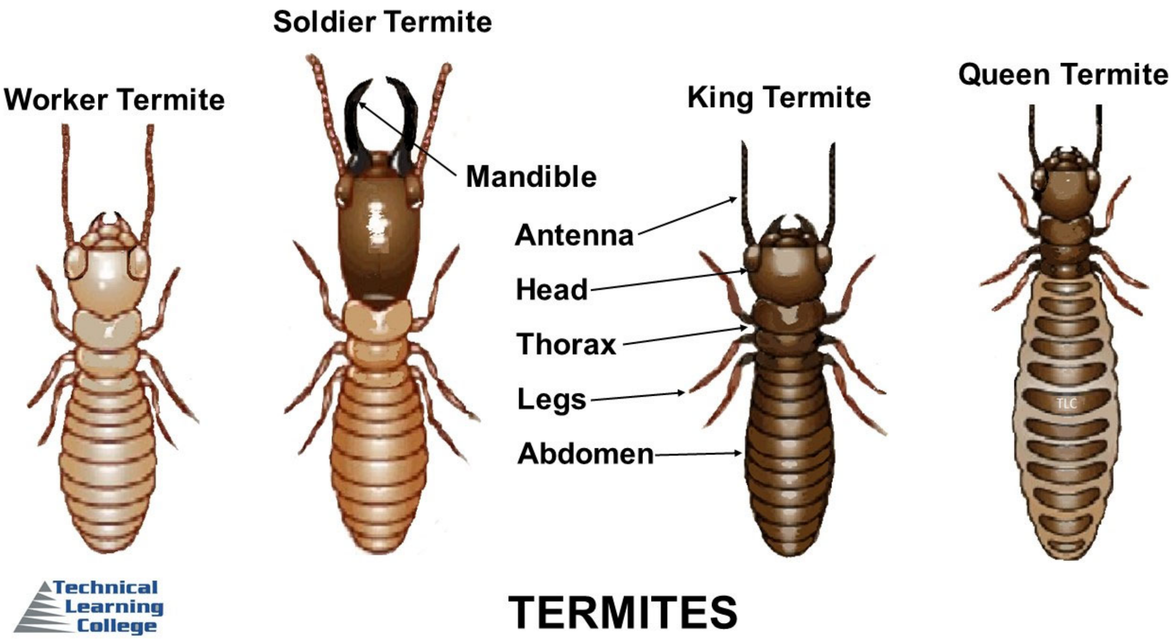
If you tear the legs off an ant, you'll have a snowman. Not so with a termite, you'll have a head and a long body. Termite swarmers have straight, bead-like antennae; a thick waist; and two pair of long, equal-length wings that break off easily. Winged termites can be differentiated from winged ants, which have elbowed antennae, a constricted waist, and two pair of unequal-length wings (forewings are larger than hind wings) that are not easily detached. Ants also generally are harder-bodied than termites.



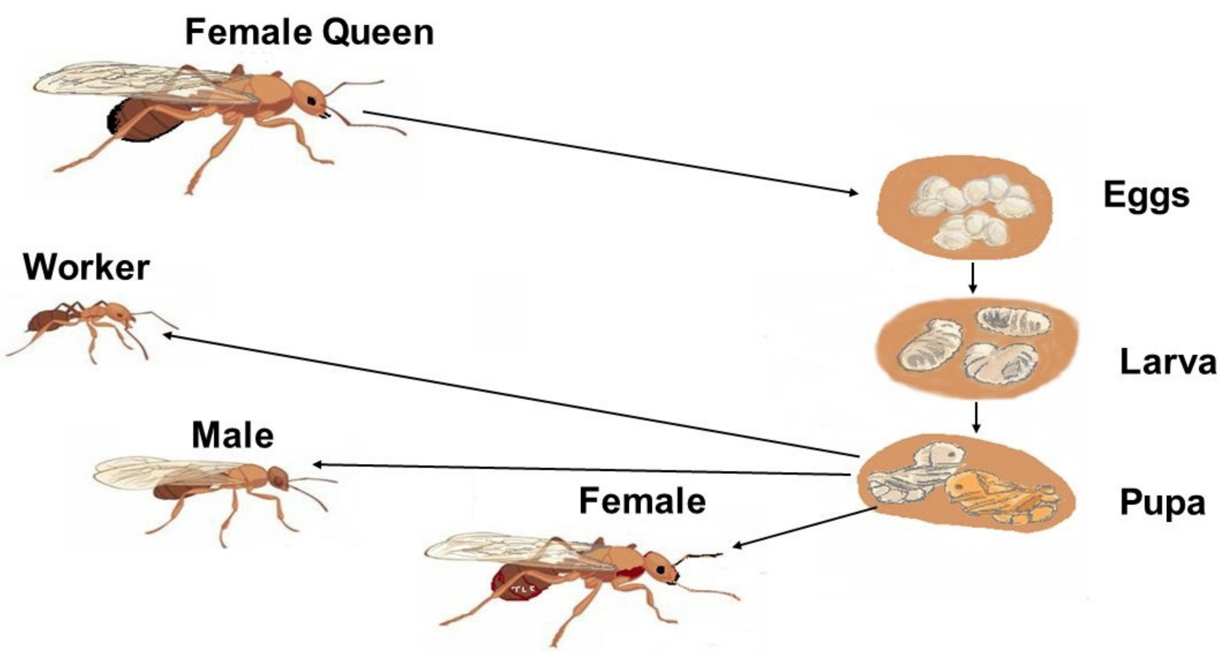




TERMITE SOLDIERS



TERMITES



ANT LIFE CYCLE DIAGRAM

Detection of Termites

It is important for homeowners to recognize the signs of a termite infestation. Some termites, like drywood are very difficult to locate. Most termites may be detected by the sudden emergence of winged termites (alates or swarmers), or by the presence of mud tubes and wood damage. We tend to think of termites as feeding/injuring wood only. Termites actually feed on almost anything that contains cellulose (the main component of wood), including wood paneling, paper products, cardboard boxes, art canvases, the paper covering of sheetrock, carpeting, etc. While foraging and feeding, they may tunnel through non-cellulosic materials, such as plastic and foamboard.

According to some research, a colony containing 60,000 workers could consume the equivalent of one foot of a 2" x 4" piece of lumber in slightly over 5 months and 1 cubic foot of wood in a year. In reality, the amount of damage that termites cause depends on many factors. In areas with cold winter temperatures, termite activity (and feeding) usually declines, but does not necessarily stop. From a practical perspective, serious termite damage usually takes about 3-8 years.

Look for these signs of termite feeding:

- Wood that sounds "hollow" when it is tapped with the handle of a screwdriver.
- Soft wood that is easily probed with a knife or screwdriver.
- A thin gritty gray-brown film on the surface of damaged material.
- There are electronic devices that work with smart phones that can see inside walls.
- There are flexible cameras that can probe into termite damage.

There is no accurate method for determining the age of recently discovered damage. You need some reference point, i.e., some point in time when it was known that there was no damage to this particular wood. This is one reason why annual inspections (and keeping your records of these inspections) are invaluable. These inspections do not guarantee that there is no damage in visually-inaccessible areas, such as inside walls. However, they can reveal conditions that might suggest that damage does exist.

Necessary Inspection Equipment

- Flashlight
- Probe “Screwdriver”
- Ladder (Termites forage attics also)
- Pencil and Graph paper
- Magnifying Glass
- Digital photograph device like a smart phone

Required Inspection

By state law, the minimum requirement for termite inspections includes visual searches of accessible areas. However, detection of difficult-to-find infestations may require removing walls, paneling, and stucco, as well as using ladders and scaffolds.

Read the pesticide product label - The label tells you exactly how the product is to be used and provides information on potential risks. If the label does not include directions to control termites and protect the structure, then the product is not intended to protect the structure against termites and should not be applied. If you wish to see a copy of the product label, ask the company representative for a copy. Always be prepared to provide a copy of the label information to the business or homeowner.

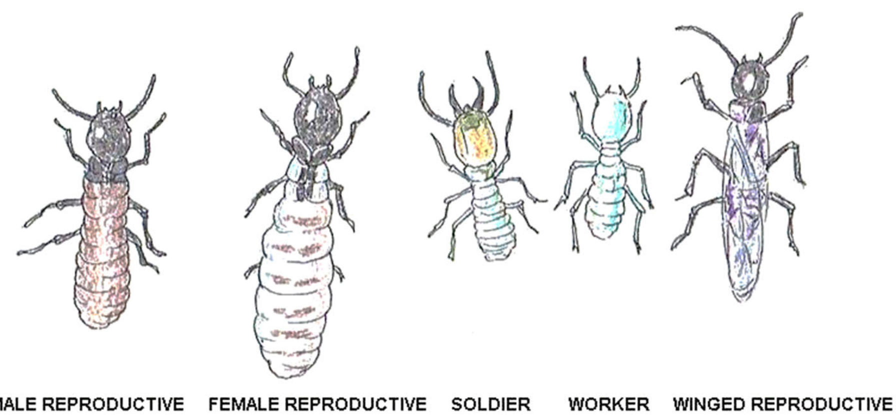
We cannot stress the dangers of pesticide application and the high death and injury rate due to applicators not following label instructions.

Be aware of the how soon you can return to the treated residence
The time required before the residence can be re-occupied will vary by product and will be indicated on product labels. Make sure to inform the business or homeowner when it is safe to reenter the building.

Winged Termites
Large numbers of winged termites swarming from wood or the soil often are the first obvious sign of a nearby termite colony. Swarming occurs in mature colonies that typically contain at least several thousand termites. A "*swarm*" is a group of adult male and female reproductives that leave their colony in an attempt to pair and initiate new colonies.

Alate emergence is stimulated when temperature and moisture conditions are favorable, usually on warm days following rainfall. Swarming typically occurs during daytime in the spring (March, April, and May), but swarms can occur indoors during other months.

However, swarming occurs during a brief period (typically less than an hour and on the species), and alates quickly shed their wings. Winged termites are attracted to light, and their shed wings in windowsills, cobwebs, or on other surfaces often may be the only evidence that a swarm occurred indoors. The presence of winged termites or their shed wings inside a home should be a warning of a termite infestation.



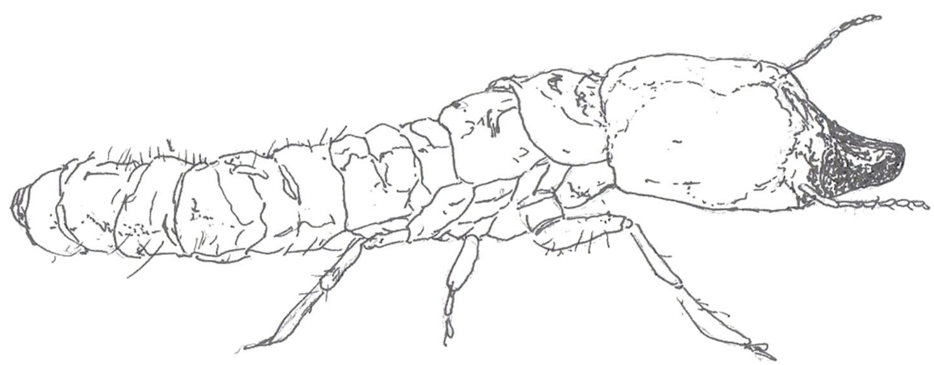
TERMITE CASTES

Termite Swarmers
Termite swarmers have straight, bead-like antennae; a thick waist; and two pair of long, equal-length wings that break off easily. Winged termites can be differentiated from winged ants, which have elbowed antennae, a constricted waist, and two pair of unequal-length wings (forewings are larger than hind wings) that are not easily detached. Ants also generally are harder-bodied than termites.

Mud Tubes

Other signs of termite presence include mud tubes and mud protruding from cracks between boards and beams. Most termites transport soil and water above ground to construct earthen runways (shelter tubes) that allow them to tunnel across exposed areas to reach wood.

Shelter tubes protect them from the drying effects of air and from natural enemies, such as ants. These tubes usually are about 1/4 to 1 inch wide, and termites use them as passageways between the soil and wood. To determine if an infestation is active, shelter tubes should be broken or scraped away and then monitored to determine whether the termites repair them or construct new ones. Houses should be inspected annually for mud tubes.



DRYWOOD TERMITE- SOLDIER

Probing interior wood trim reveals termite damage. Subterranean termites do not reduce wood to a powdery mass, and they do not create wood particles or pellets, as do many other wood-boring insects. Depending upon your State or climate, up to half of your work may be termite management. Termite control is an excellent profit making portion of normal pest control activities, however, it is very labor intensive at times.

This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

Differences Between the 2 Primary Termite Species

	DRYWOOD TERMITES	SUB TERMITES
FOOD	CELLULOSE (derived from wood and wood based products.)	CELLULOSE (derived from wood and wood based products.)
MOISTURE	No outside moisture needed. Can survive on a small amount of moisture within wood.	Require an outside moisture source. This may be from the soil, leaky plumbing, roof tops, etc...
ENVIRONMENT	Colonies live within the wood and do not require contact with the soil.	Normally live and forage in the soil. Can establish a nest above the soil if an acceptable moisture source is found. Build protective mud tubes that lead from the soil to the home. Can move colony within soil when environmental conditions require.
COLONY SIZE	SMALL (few hundred to a thousand termite members.)	LARGE (A well-established colony may contain over 7 million termites. Some species have numerous smaller colonies of several thousand termite members.)
EVIDENCE OF ACTIVITY	"Sand-Like" pellets or "droppings". Kick-out holes on the walls, ceilings or wood. Infestation may take two years before evidence of droppings is present.	1) Mud Tubes ascending from the ground to the structure or protruding from walls and/or trim. 2) Heavy termite swarming within the structure 3) Slits in the wood (flight slits) 4) Uncharacteristic waviness in the wood.
PREVENTIVE MEASURES	1) Use treated lumber during construction. 2) Coat any untreated wood or exposed wood end cuts with an appropriate termiticide. 3) Seal all cracks and crevices with caulking.	1) Install a termite monitoring or detection system at the home or structure. 2) Perform treatment to the soil before construction with an appropriate termiticide. 3) Eliminate conditions conducive to infestation.

CONTROL MEASURES	Light Activity: 1) locate kick-out holes 2) lightly puncture kick-out hole 3) inject appropriate insecticide in kick-out hole. 4) Seal kick-out hole with caulk. Heavy Activity: Tent fumigation	**Prevention through education, detection and elimination of conducive conditions are the most effective and cost efficient control measures. When activity is already present, treat the structure with a liquid termiticide.
DAMAGE LEVEL	Minimal* * When compared to subterranean (ground) termites. Takes up to two years for evidence of activity to be present.	Some species of subterranean termites can consume 15 pounds of wood per week.

Alates - Below is listed a comparison of Formosan alates and the three common native subterranean species.

	Formosan	R. flavipes	R. virginicus	R. hageni
Body Size	12-15 mm (0.5 – 0.6 in.)	8-10 mm (0.3 – 0.4 in)	4.5-5 mm (0.1 – 0.2 in)	4.5-5 mm (0.1 – 0.2 in)
Body Color	Light yellow-brown	Black	Black	Light yellow-brown
Wings	Covered with fine hairs	No hairs	No hairs	No hairs
Wing size	> 11 mm (0.4 in)	8-9 mm (0.3 in)	6.5-7.5 mm (0.25 in)	6-7 mm (0.2 in)
Flight times	May – July Night	Feb – April Day	May-June Day	August Day
Antennal Segments	Greater than 20	Less than 20	Less Than 20	Less than 20

Termite Identification Sub-Section

Subterranean Termites

Western Subterranean Termite *Reticulitermes hesperus*

The western subterranean termite, *Reticulitermes hesperus,* is native to most forest areas where it performs the important task of breaking down the large quantities of dead and fallen trees and other sources of cellulose that continuously accumulate in the forests.

The Western subterranean termite is one of the most destructive termites in North America. It is a serious economic timber pest causing millions of dollars of damage throughout the areas where it is located. It is estimated that more than 1 in 5 homes in the high risk activity areas, been or will be attacked at some time by these voracious little insect. Unfortunately, they also attack wooden structures and, if left uncontrolled, will cause weakening and collapse of the structures due to their feeding activity. Other wood products can also be attacked under the right conditions. The presence of termites in buildings is cause for concern not only from the standpoint of safety but also in terms of the cost of preventing further structural damage and replacing damaged wood.

The Western subterranean termite is the most common and most widely distributed termite in the western half of North America. It is a problem for homeowners from British Columbia in Canada, south to western Mexico and east as far as Idaho and Nevada.

Western subterranean termites are in plague proportions in central and southern parts of California, particularly in the older urban areas of the San Francisco Bay Area, Sacramento, Reno, Fresno, Los Angeles, Orange County, San Fernando Valley and San Diego.

This native American pest can enter structures through cracks less than 1/16 of an inch wide, even the minute openings found in concrete slabs, around drain pipes, and between the slab and the foundation.

Western subterranean termite colonies are usually located in the ground below the frost line, but above the water table and rock formations. They are typically detected by the presence of the mud tubes they construct, or when large numbers of winged termites "swarm" or leave the colony to search out mates. Swarms occur in the daytime, and in California, they occur on warm, sunny days during the fall, winter or early spring. In the northern sections of the termites' range, spring swarms commonly occur in the absence of rainfall.

Western subterranean termites are highly destructive to Douglas fir and other common building timbers. Western subterranean termites rapidly eat out the internal sections of structural timbers - devouring mainly the spring wood, and preferring to leave the harder summer wood sections.

Western subterranean termite workers look like white or cream-colored ants. Soldiers have an orange, rectangular-shaped head with large pincher- like mouthparts that are used to fight off colony invaders. Swarmers are about 3/8-inches long (wings included), and their body is dark brown. They have two pairs of wings, and the front wings are larger than the hind wings.

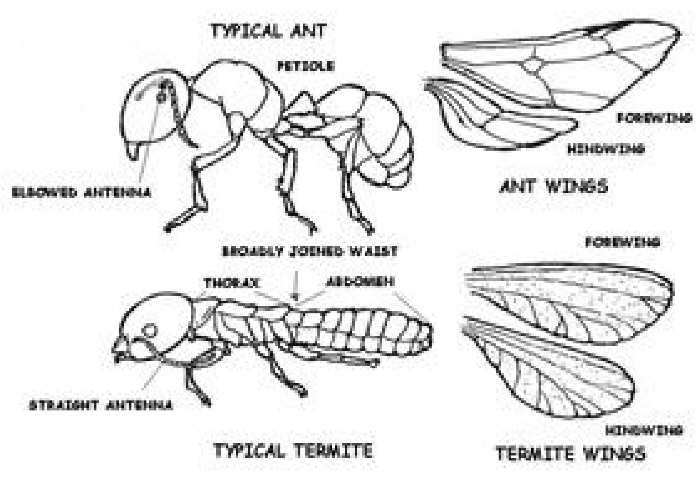
Thin Honeycomb Shell
Western subterranean termite infested timbers are often left as a thin shell with a honey-comb of layered hollow sections (as illustrated on left) packed with a composite of partly digested timber and soil extract. If this soil timber composite is moist, chances are you'll also find live termites close by. Western subterranean termites prefer a moist dark damp environment - it is essential for their survival.

Social Interdependence
Within a termite colony there are members of different castes, each with a different role to perform and all interdependent upon each other for the survival of the termite colony. The different castes include the queen, king, the winged reproductive (young kings and queens), soldier and worker termites.

Biology and Description
The western subterranean termite is a social insect, living in colonies that have just a few thousand to sometimes millions of individuals. Each colony will include reproductives, workers and soldiers. Winged reproductives emerge in a mass nuptial flight in April and May. These flights are often the first indication homeowners have of termite infestations. A small emergence may occur in late summer.

Reproductives are about 5-6 mm long and are often confused with winged or '*flying*' ants because of their black bodies and transparent wings. The following figures illustrate how to distinguish between the two types of social insects. The waist of ants is narrow whereas termites have a broad waist between the thorax and abdomen. The antennae of ants are elbowed whereas those of termites are straight with bare bead-like segments.

Ants have two pair of transparent wings with few veins and are not of equal length, and often have a dark patch along the outer margin of the front wing, whereas the wings of termites are about equal in length (8-9 mm) and have many fine veins.

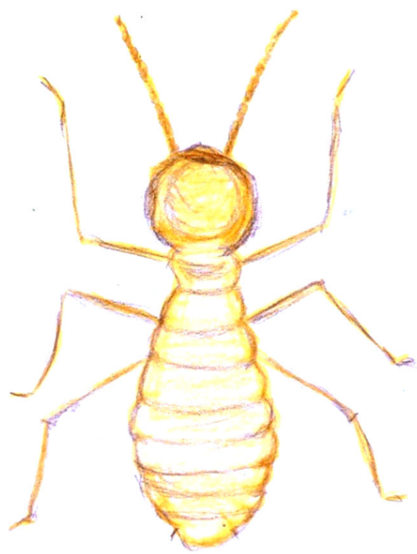


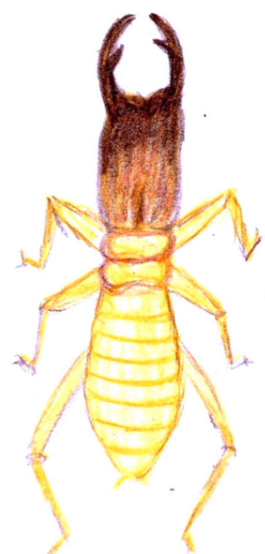
Courtship Run
After flight, males and females will break off their wings, form tandem pairs that have a courtship run on the ground, and then together seek a suitable site to begin a colony--in wood buried in the ground or laying on the surface of damp ground. The initial rate of colony growth is slow, however additional egg-laying females are produced which increase the rate of colony development.

Large colonies will subdivide if food sources are abundant. Winged adults do not appear until the colony is 3 or 4 years old, then mass emergences will occur each year.

Worker Termites
Worker termites are ¼ inch (6 mm) long and pale cream in color (worker ants are yellow, red, brown or black); soldier termites are the same size and color; however, their heads are enlarged (almost half their body length) with noticeable black jaws.

Soldiers will tap their heads against the wood when disturbed which is another means of detecting the presence of termites. Workers construct the distinctive shelter tubes and collect food to feed the young and other members of the colony. Soldier termites are responsible for guarding the colony and its occupants. Termites continually groom each other to obtain certain secretions. These secretions help regulate the number of individuals in the various castes.


Worker


Solider


Queen

Identification Tips Western Subterranean Termite - Soldier Caste
The Western Subterranean soldier termites have an orange colored rectangular armored head with mandibulate pinchers which they use to crush member of the ant family - their arch enemy in the insect world. The Western subterranean termite soldier has a fontanelle (frontal gland pore or hole) on their forehead used to squirt a white sticky latex, mainly as a defense mechanism against ants.

The soldier termite is usually the first to be seen in large numbers when any active termite workings (mud shelter tubes or damaged timber) are opened. Soldier termites will rush out to guard the opening whilst worker termites repair the breach.

Termite Alate Swarmers (or reproductives) are commonly seen when they swarm during daylight; they have eyes; are poor fliers but are swept along by the wind; they land, drop their wings, find a mate to become king and queen of a new termite colony.

Western Subterranean Termite Identification Tips - Alate Caste
The western subterranean termite swarmers are about 3/8" long (including wings) with a dark brown body and a small fontanelle (frontal gland pore) on its head. Their wings are brownish grey with two dark solid veins along the forefront of the front wings. The front wing is distinctly larger than hind wing.

Swarming
In the northern part of their range, swarming takes place in the spring, but without rain. In the southern areas, swarming usually follows rain. The swarmers are emitted in their thousands when a mature termite nest is large and well established.

Western subterranean termites swarm in large numbers over a wide area to find a mate from another colony nest to start up a new colony. A suitable location for nesting should provide moisture and a readily available timber food source close by.

During the warmer months you may see the flying alates (winged reproductives) caste take to the air and swarm in their thousands, in order to meet up with swarmers of other nests in the area so they can establish new termite colonies in the local area. This is a sure DANGER sign that a large mature termite nest is close-by. Such a nest may contain hundreds of thousands of Western subterranean termites within range of infesting the timbers in your home.

Colony Information
Colony nest development is slow in the first few months, with the egg-laying capacity of the new queen termite peaking after a few years. The swarmers are emitted in their thousands when a mature termite nest is large and well established. Swarmers are usually produced after this period and are an indication a large termite nest is in the vicinity, a sure danger sign and a warning that professional treatment is required.

The colony nests of Western subterranean termites are usually located in the ground below the frost line, but above the water table. Mud galleries or "shelter tubes" are constructed across hard objects in order to gain access to timber food sources.

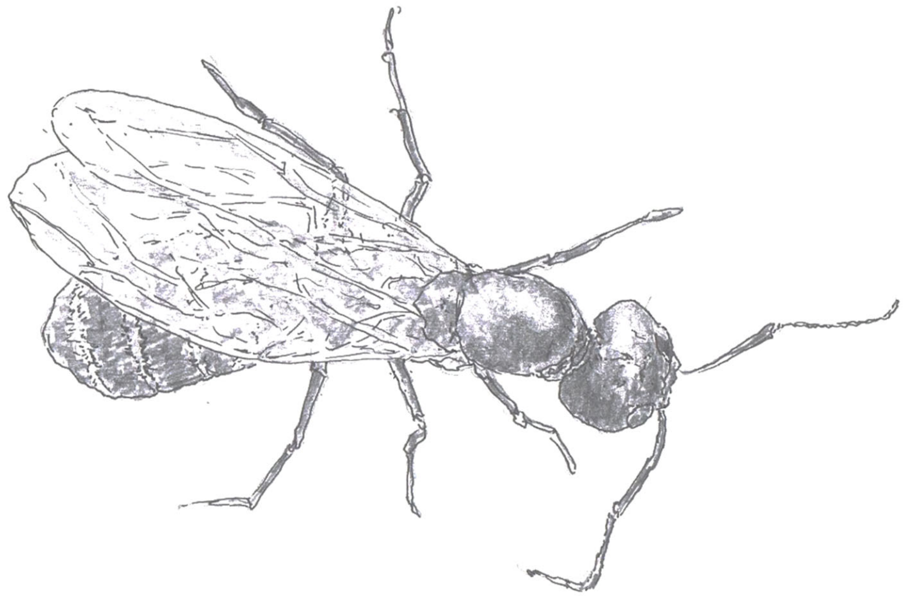
Western subterranean termites constantly search for new food sources. They are known to enter buildings through cracks in concrete flooring or to travel under parquetry or tile flooring through gaps of less than 1/16" wide.
Where moisture regularly collects inside the wall or other cavities of a building, possibly from faulty plumbing or broken roof tiles, the Western subterranean termite can develop a subsidiary colony nest that may not require contact with the ground to ensure its survival.

They build a central colony nest from which they construct underground tunnels that radiate within a 100-yard radius from a central colony nest in search of a timber (cellulose) food source.
Western subterranean termites travel in these mud shelter tubes as protection from predators, sunburn, dehydration and to maintain a high humidity environment that is essential for their survival.

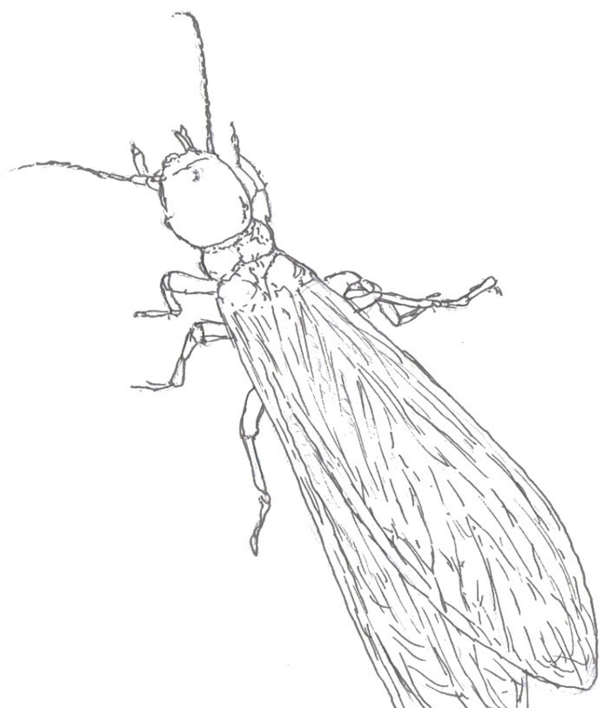
Western subterranean termites are highly secretive, preferring to enter a building through areas inaccessible to inspection, such as, through in-fill patios, fire heaths, expansion joints and cracks in concrete slab (on-ground) flooring.

Western subterranean termites can pass through a 1/8" crack or an expansion joint (eating through the rubber compound) between adjoining concrete on ground flooring. Western subterranean termites can also travel under timber parquetry and other floor tiles to get to the wall framing timbers in a building.

Western subterranean termites have acute survival instincts. If they are shaken up or disturbed, the termites often will abandon the associated area and move on to secretly cause damage in other areas in the building.



WINGED ANT



WINGED DAMPWOOD TERMITE

Desert Subterranean Termites

Have you been to the desert and seen a piece of wood that looks normal until you pick it up and the board is nothing but a hollowed out shell? Desert subterranean termites are commonly distributed throughout the lower deserts of northwestern Mexico, southern California and southern Arizona.

Here are a few important facts you should understand about the life and behavior of desert subterranean termites, compared to the more common Eastern or subterranean termites such as Formosan or Eastern subterranean:

- Desert subterranean termites are able to survive in drier conditions than Formosan or Eastern subterranean termites.
- Soldiers of desert subterranean termites are characterized by their slender and straight mandibles, in contrast to the relatively thick, curved mandibles of Formosan or Eastern subterranean termites.
- Their small size and ability to forage under dry conditions allows them to occupy a niche not exploited by other subterranean termite species.
- Preliminary research suggests that baiting for desert subterranean termites requires more time than for others. Given the small size of desert subterranean termite soldiers and workers, they are apt to penetrate smaller cracks in concrete and masonry that are too narrow for foragers of other subterranean termites to enter.
- Subtle differences in foraging behavior do exist. Foraging tubes are lighter in color, narrower, and more circular. Sometimes, desert subterranean termites will openly build very narrow, free-hanging tubes from ceilings, shelves and overhangs.
- Don't be surprised to see tubes as long as 6 to 12 inches in length. These tubes are often re-used by desert subterranean termites.

Identification of Swarmers and Soldiers
The Desert subterranean termite swarmers are about 3/8" long including their wings. Their body is a pale yellowish brown and a fontanelle (front gland pore) is indistinct or absent. The wings have two prominent hardened veins in the front portion. The wing membrane is translucent, almost colorless, with a few barely visible hairs. The front wing is larger than the hind wing.

The head of the Desert subterranean termite soldier is rectangular in shape, the length about twice the width. It also has a fontanelle (front gland pore) on the forehead. The body (pronotum) is flat and almost as wide as the head.

The Desert subterranean termite soldiers have long powerful pointed jaws (mandibles) that are slender, fairly straight but slightly curved inward at the tip. This contrasts with the mandibles of the Western subterranean termite that are thick and curved.

The small size of Desert subterranean termites and their ability to forage under dry conditions allows them to occupy a niche not exploited by other subterranean termite species.

Identification of Timber Damage

Desert subterranean termites prefer to eat the springwood in timbers, generally avoiding the lignin in summerwood. Damaged timber appears honeycombed, with soil in the galleries. The Desert subterranean termite is less dependent on moisture and decay than other subterranean termites. It will readily attack dry, sound wood. A typical sign of infestation is the presence of “drop tubes” coming from the ceiling rafters and sheetrock/plasterboard and/or holes in the sheetrock plugged with feces.

Identification of Mud-Shelter Tubes

Desert subterranean termites prefer to forage in shaded soil or areas made wet by irrigation. They will readily construct mud shelter tubes up, over or around solid objects in order to reach a timber food source. These mud-tubes are slender, solidly built and pale yellow to tan in color. Desert subterranean termites’ mud-tubes are more circular in cross section than those of the Western subterranean termite whose mud-tubes are flattened in cross section and dirty light brown in color.

Biology and Habits

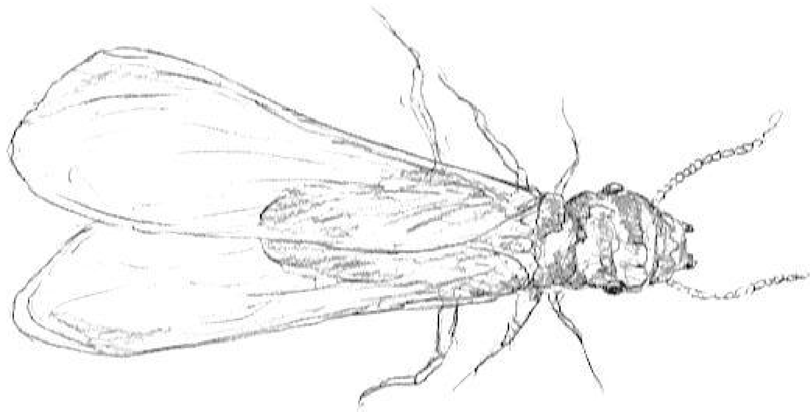
Desert subterranean termites most often swarm at night during the rainy season, from July to September, usually after rainfalls. The moist soil provides the nuptial Desert subterranean termite swarmers with the best chance of surviving and developing a new colony. The male and female pair off and enter the soil where they excavate a cavity or cell. A well-developed mature colony of Desert subterranean termites may contain more than 300,000 termites, including a large number of secondary reproductives (queens) that can readily break off from the primary colony to form separate colonies. Desert subterranean termites commonly have a foraging territory of up to almost an acre.

Desert subterranean termites require only a tiny gap, about 1/32", in concrete flooring or mortar joints in brick walls to gain access to the wall, roofing and other structural timbers in a building. The Desert subterranean termite can penetrate cracks in concrete and masonry that are too narrow for foragers of other subterranean termite species to enter. Desert subterranean termites often build their mud-shelter tubes as freestanding tubes that "drop down" from rafters, ceilings and subfloor areas under buildings.

Some quick facts about Western Subterranean Termites

- Although Western subterranean termite colonies are largely located in the ground, secondary colonies can exist above ground if there is a constant source of moisture.
- Western subterranean termites will often build mud tubes for travel between their colonies and their food sources.
- Damage caused by Western subterranean termites is most commonly found in the basement and at ground level, although the termites will attack wood at higher levels.
- Development from eggs to adults may take more than 5 months, and workers may live from 3-5 years.
- Swarmers are usually produced from mature colonies that have been active for a number of years.
- Research has shown that populations are higher in urban areas than in undeveloped habitats. The termites prefer soil temperatures between 84° and 90° F — never above 104° F.

Drywood Termite (Kalotermitidae)



DRYWOOD TERMITE SWARMER

Approximately 400 global species of drywood termite species are known, but only a few species are important in the United States. Drywood termites live in dry sound wood (usually less than 12% moisture), and derive their moisture requirements from the wood they consume. Infestations can occur in structural timbers in buildings, pieces of furniture, flooring, doors and doorframes, window trim, wooden picture frames, and other isolated pieces of wood. Drywood colonies are relatively small, with a few thousand members lacking the true worker caste, and there are often multiple colonies in the same structure.

Drywood termites do not need a connection to soil and there is no soil in their feeding galleries. They do not build mud tunnels; they construct large, irregular galleries that run across and with the wood grain, with a very smooth, clean, and sandpaper-like appearance. The galleries are connected by openings small enough for one termite to pass through. The sure sign of drywood termite feeding is their fecal pellets that are ejected from the galleries via kick-out holes, often found right below the damaged wood. These pellets are quite unique and are hard, elongated-ovals with rounded ends, and have six concave sides.

Powderpost Termites
Powderpost or "furniture termites" (Cryptotermes spp.) have small fecal pellets and are smaller in size than other drywood termites. Their feeding on furniture or movable wooden objects can reduce wood to a fine powder. They can be found in Florida, southern Louisiana, Texas, Puerto Rico, and Hawaii. Some have been found as far west as Los Angeles and as far north as Ontario, Canada. These creatures are also found in antique furniture.

Drywood termites are hidden insects that are difficult to detect. They live deep inside wood; and except during periods when they swarm or when repair work is being done on infested homes, they are seldom seen.

Colonies are small (usually fewer than 1,000 individuals), can be widely dispersed, and take years to mature. The most common sighting of drywood termites is flying adults (called swarmers) that occur during daytime hours during summer and fall.

Dampwood termites also can swarm during summer and fall, but they can be differentiated from the western drywood termite based on their larger size and attraction to lights at dark. In parts of southeastern California another species of drywood termite, Marginitermes hubbardi, and species of desert subterranean termites may also swarm to lights.

While a homeowner may initially detect the presence of drywood termites when they swarm or if fecal pellets are discovered, inspecting and determining the extent of an infestation requires experience and is best done by a professional.

By state law, the minimum requirement for termite inspections includes visual searches of accessible areas. However, detection of difficult-to-find infestations may require removing walls, paneling, and stucco, as well as using ladders and scaffolds.

During a structural inspection for drywood termites, inspectors look for feeding damage, shed wings, fecal pellets, and kick-out holes, i.e. small holes (less than 2mm in diameter) through which termites push fecal pellets out of the wood. Again. These unique fecal pellets have six hexagonal sides and are diagnostic for drywood termites. It is not possible to determine, from fecal pellets alone, whether the infestation is currently active or how extensively the infestation extends throughout the wooden piece or structure.

Dampwood termites also produce fecal pellets that are rounded at both ends (football shaped) and elongated, but they lack the clear longitudinal ridges common to drywood termite pellets. Other structural pests that can be confused through differential diagnosis include wood boring beetles and carpenter ants, see the Wood Boring Beetles of the Home and Carpenter Ants pest section of this course. The final confirmation of drywood termite pellet identification from other wood destroying pests or wood debris may require help from an expert. Cleaning up the fecal pellets around a kick-out hole and checking a few days later to see if new pellets have appeared can help to determine if an infestation is active (as building vibrations and movement may also cause some pellets to appear).

Other detection methods that have been commercialized and tried by the pest control industry include dogs, feeding-sensitive (acoustic emission) devices, fiber-optical devices, movement-sensitive (microwave-based) devices, and odor detectors; but these methods are infrequently used. Visual inspection by inspectors for evidence of termites and damage remain the mainstay of the industry.

Drywood Termite Management

Because of the difficulty in detecting drywood termites and determining the extent of the damage, do-it-yourself treatments are not recommended. In addition, the chemical products needed for controlling these pests are not generally available for homeowner use. Except for wood removal, homeowners should seek help for infestations of drywood termites from pest control professionals.

Existing Infestations

All drywood termite control methods can be categorized as either whole structure or localized. More information, see the section in the rear of course that summarizes the advanced control methods and elimination.

A whole-structure treatment is defined as the simultaneous treatment of all infestations, accessible and inaccessible, in a structure.

Localized or spot treatment is more restrictive and is often applied to a single board or small group of boards. Homeowners should be advised to understand the distinction between whole-structure and localized treatments when deciding which method to select, because all treatment methods are not equal.

Whole-structure treatments have an advantage over localized treatments in that they should eliminate all infestations, even hidden ones. With the uncertainty of current detection methods, particularly when drywall or other wall coverings conceal infestations, there is always some doubt as to the extent of drywood termite colony boundaries and the number of colonies within homes. Consequently, one can never be sure all infestations have been treated when applying localized treatments. The strengths and limitations of whole-structure vs. localized treatments are outlined in the rear section of this course under advanced termite control.

Detecting Drywood Termites
These highly designed creatures nest above ground, away from soil. Since colonies are usually constructed inside wood, finding these termites can be difficult during routine pest and dry-rot inspections. Therefore, one of the best ways to identify an active infestation is the presence of fecal pellets. These pellets are cream to reddish-brown or black. The color of the pellets is not related to the color of the wood. The pellets are about 1-2 mm long and distinctively six-sided, making them easily distinguishable from other wood destroying organisms. Pellets usually fall into piles as the termites push them out of the infested wood.

Fecal Pellet Differences
Drywood termite fecal pellets are kicked out of the colony by workers and may accumulate below infestations. Fecal pellets have a distinct ridged shape and are about 1/25" long (about the size of table salt). Subterranean termites do not kick out dry fecal pellets from their colonies and drywood termite fecal pellets are much larger than the boring dust particles of Powderpost beetles.

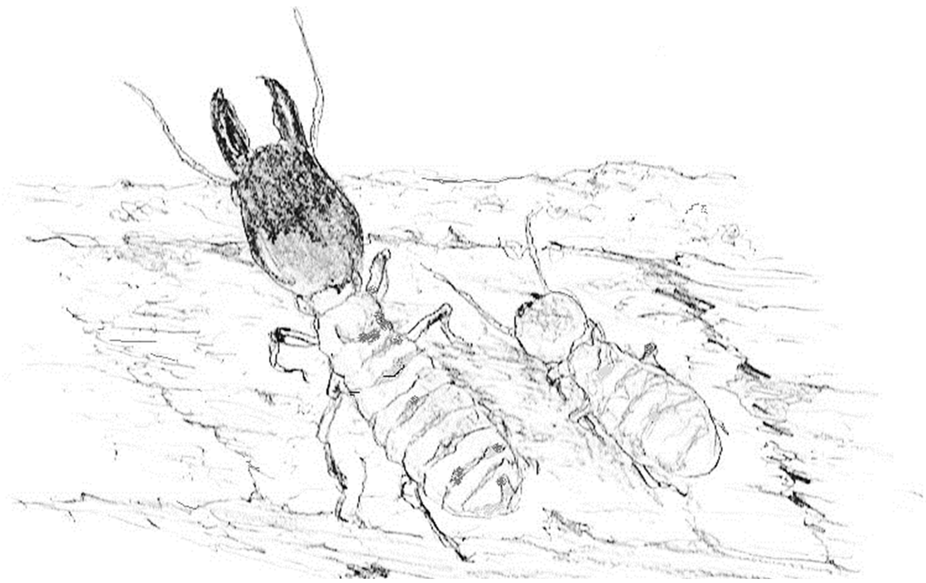
Infestation Signs
Signs of infestations by drywood termites and control measures differ drastically from those for subterranean termites.

- Discarded wings accumulating around window sills or in spider webs
- Signs of infestation include:
- Winged insects emerging in evenings and night attracted to lights or TV.
- Wooden pellets (much smaller that rice grains) accumulating on floors or under furniture.
- A sign of advanced infestation is surface blisters. These termites sometimes tunnel close to the surface giving the wood a blistered appearance. Infestations may be detected by tapping the wood every few inches with the handle of a screwdriver. Damaged wood sounds hollow - a papery rustling sound indicates tunnels just beneath the surface.
- Baiting systems (such as Sentricon, First Line, Exterra) will not protect a structure from drywood termites
- Coastal and southern areas of the state are more likely to have an infestation of drywood termites occur.
- Colonies are smaller and develop over a longer period of time than do subterranean termites therefore the potential for structural damage over a given period of time is less.
- Control methods include whole structure fumigation, spot treatment with insecticides, or spot heat, shock, microwave, and liquid nitrogen treatment. Heat treatments have been used as whole structure treatments.

• Direct treatment of lumber MAY provide protection if the drywood termites must tunnel through the treatment to infest the wood.
• Drywood termites occur in small colonies in isolated wood pieces. Multiple colonies can infest a structure simultaneously
• Drywood termites remain hidden within the wood or other material on which they feed, so they seldom seen. Fecal pellets are ejected periodically, while swarmers fly from colonized wood in late spring and summer.
• Drywood termites will also infest pieces of furniture (particularly antique pieces). Removal of the item and separate treatment of the piece may be all that is necessary in some instances.
• Even though colonies are slow to develop if left unchecked for extended periods of time substantial damage can occur.
• Galleries or tunnels in the wood made by drywood termites cut across the grain of the wood and destroy both soft spring wood and the harder summer growth. Galleries made by the subterranean species follow the grain of the wood and the soft spring wood is attacked first.
• In some cases, treatment of an infestation of drywood termites may not be needed if the area of infestation can be identified and physically removed (this may or may not be practical from a structural standpoint).
• Late Spring and Summer months are the peak season for winged drywood termite swarming flights.
• Swarming (mating flights) often occur in the evening hours.
• Termite protection contracts are usually for ONE type termite only. A SEPARATE contract is usually required for treatment and protection from subterranean termites and drywood termites.
• Treatment of the soil under and around the structure will not protect a structure from drywood termites
• Winged termites can be distinguished from winged ants because termites have a thick waist, straight antennae, and equal-length wings whereas ants have a distinctly thin or wasp-like waist, elbowed antennae, and shorter hind wings than fore wings.

Summary
Drywood termites are important structural pests in tropical and warm/dry climates. Unlike most other termites, drywood termites do not need contact with soil moisture. Control of "drywoods" can be more difficult because their colonies are not confined to the soil.

Pacific Dampwood Termite *Zootermopsis angusticollis*



DAMPWOOD SOLDIER (L) NEXT TO WORKER TERMITE

The Pacific dampwood termite is the largest and the most significant dampwood termite in the United States. This species ranges from Baja California and Mexico to British Columbia. They have been found up to 6,000 feet above sea level, but more commonly in the cool and humid coastal areas. These termites get their name from the need for a high moisture content in the wood. They are extremely common in wooded or forest environments in cooler climates. Colonies are generally small by termite standards, with several thousand workers in a mature colony. There is no true worker caste, as nymphs perform the duties of the colony and all nymphs become either adult soldiers or adult alates. Alates swarm after sundown on warm summer evenings. The reproductives may attack wood without soil contact. Damage is indicated by large galleries that usually follow the direction of the grain, and with fecal pellets packed into some of these galleries. The texture of the sides of the galleries is “velvety”, or slightly rough textured.

Identification of Swarmers and Soldiers
Swarming may occur throughout the year, but most often from August through October. Swarming usually will occur on warm humid evenings just before sunset. The reproductives are strongly attracted to light. Swarmers are up to 1" in length and are light to medium brown with dark brown wings.

The Pacific dampwood termite colony consists of three castes: reproductives, soldiers and nymphs. Winged reproductive, or alates, are almost one-inch long and their color ranges from yellowish-brown to cinnamon-brown. Soldiers display flattened heads with brown or yellowish-brown coloration, while their jaws are black or dark brown. Nymphs are cream colored. Pacific dampwood termites are also known as “rottenwood termites” due to their preference for very moist wood. (Other species of dampwood termites are also called “rottenwood termites”. Soldiers have a large head armed with long black toothed mandibles. The anterior portion is black generally shading to a dark reddish-brown in the posterior position.

The abdomen and thorax are a light caramel color, the abdomen varying according to the stomach contents at the time. The largest termites in the United States, soldiers may be very large, reaching 5/8 to 3/4".

Identification of Timber Damage
The tunnels vary greatly in size and shape and in sound timber may favor the softer springwood. Fecal pellets are found throughout the tunnels, and are hard small, oval and about 1/25“long. The color of the pellets may vary according to the type of wood being consumed.

Pacific Dampwood Termite Biology and Habits
This species will attack wood of all types throughout its range. Timbers in contact with the soil or structures built near or over water are common targets. This species is known to be very tolerant of moist conditions, even being found in pilings subject to tidal flooding. Colony size varies but may contain as many as 4,000 individuals.

Colony growth is aided by the production of secondary reproductives. Like other termites this species aid in the spreading of wood decay fungi, the spores of which are carried in the gut and on their bodies. A well-established colony will produce winged reproductives which may infest nearby timber.

Summary
The life history of the Pacific dampwood can be summarized as follows. Both male and female swarmers excavate a chamber, they enter, and the chamber is sealed. They mate and within about 2 weeks, eggs are laid and the colony is founded. The queen lays about 12 eggs. The second batch is laid the next spring.

Swarms tend to occur on warm, humid evenings during the late summer or early fall, often appearing after early rains. These swarms are smaller than those of other termite species, as Pacific dampwood termite colonies only foster up to about 4,000 members. After mating, male and female alate pairs usually begin the new colony in sound wood such as recently cut logs and the living parts of otherwise dead trees.

Comparison of Dampwood Termites
Pacific Dampwood Termite
The Pacific dampwood termite colony consists of three castes: reproductives, soldiers and nymphs. Winged reproductive, or alates, are almost one-inch long and their color ranges from yellowish-brown to cinnamon-brown. Soldiers display flattened heads with brown or yellowish-brown coloration, while their jaws are black or dark brown. Nymphs are cream colored. Pacific dampwood termites are also known as rottenwood termites due to their preference for very moist wood.

Desert Dampwood Termite
The swarmers, or winged reproductives, kings and queens of this species are dark brown; soldiers are brown or yellowish in color; and nymphs have spotted abdomens. Probably the best way to determine the presence of these termites, as well as other species of dampwood termites, is the appearance of the infested wood. Tunnels that have very smooth walls – looking almost like they have been smoothed out by a woodworker using sandpaper, connect chambers within the infested wood.

Desert Dampwood Termite *Paraneotermes simplicicornis*

Desert Dampwood Termites are found in Arizona, New Mexico, Texas, and Southern California. Living where the habitat is dry and arid in these regions of the United States. They ingest damp wood that is buried in the ground. Munching termites attack tree roots, bushes, door frames and fence posts. The Dampwood also feeds on live trees – wood that is under ground level.

Dampwood termites are almost an inch long, which is quite a bit larger than the Subterranean or the Drywood variety. Swarming occurs between January and October – which is a long swarming season. These insects only infest wood and timber that contains high water content. The 'Dampwoods' come in a variety, and each is named for the location in which they are found: Desert Dampwood Termites, Florida Dampwood Termites, Nevada Dampwood Termites, and Pacific Dampwood termites.

Identification of Swarmers and Soldiers
The swarmers of this species are dark brown, swarming during the daytime. This species prefers the arid and semi-arid regions of the southwest, from Texas through California and Mexico. A prevalent pest for gardeners, these termites are known for destroying vegetation, notably citrus. These pests also prefer to attack timber and other wood high in moisture. Desert Dampwood termites are also notorious for emitting a strong odor, and unlike other termites does not create mud tubes. They can be found residing in dampened wooden areas, and are not likely to burrow in soil.

Identification of Timber Damage
This species infests wood at or below ground level in the southwestern United States. It sometimes girdles young citrus trees and grapevines below the soil line in desert areas. In the southwest it attacks living trees and bushes and is a problem for citrus groves. It is a pest of timbers in service, infesting moist timbers that are in contact with soil. Untreated posts, poles, and fences are attacked below ground level.

Desert Dampwood Termite Biology and Habits
This species does not build mud shelter tubes above the ground in order to reach wood. This is an unusual dampwood termite in several respects. The colonies extend from the wood into the soil, they sometimes kill living shrubs and trees, frass is cone-shaped rather than cylindrical, and the termites have a pungent odor. They also have directed trail-following behavior, unlike other dampwood termites.

The nymphs are the caretakers of the colony and feed the kings, queens and the soldiers. This desert termite prefers to eat damp wood that is below ground, but will also consume shrub or tree roots, fence posts and doorframes. Desert dampwood termites also damage living trees by feeding on and girdling them below the ground surface.

Paraneotermes simplicicornis causes significantly less economic damage than subterranean termites and other dampwood termite species. Desert dampwood termites seldom infest homes, but when they do, they are likely to be found in wet wood that is kept damp by water leaks or excessive moisture from standing water. Therefore, the presence of this termite often indicates moisture and wood decay within the home. For this reason, it is very important to make sure that gutters and downspouts work properly to drain rainwater away from the house.

This desert species **rarely damage homes** like others of their kind. The desert dampwood termite is **not classified as a major** structural pest in the United States.

When found in a home they are usually found in wet wood or wood that is kept wet by constantly dripping water. Occasional infestations of dwellings are commonly found in door frames or baseboards.

The desert dampwood termite is the only dampwood termite considered a pest of wooden structures in Arizona.

The swarmers, kings, and queens of the Desert Dampwood Termite species are brown. They have brown bodies and brown wings.

Soldiers are yellowish brown, and nymphs are a creamy color with a spot on their abdomen. This spot indicates the presence of food.

Description

- Soldiers are up to 5/16" long with flat heads and short wide black mandibles. Desert Dampwood Termite soldiers also have an antenna on either side of their head.
- Nymphs take care of the colony and feed the others. This muncher's favorite food is damp wood even though they like dryer weather climates. If trees around your home show signs of infestation, you may need to take them down. Weak wood trees are a hazard to the home.
- The winged adults swarm starting in May until September – in the daytime. Termites swarm, mate and start a new colony. The desert dampwood prefers citrus trees and can use the sap for required moisture.
- This termite has a strong odor.
- This species does not build mud tubes to stay hydrated or to reach a wood source. The colony itself will stretch out over a distance to go from wood to soil. This distinction makes the Desert Dampwood Termite different from others of its kind.
- The desert termite lives in small colonies – less than 1500 termites. If infected wood is found – look closely for tunnels inside the wood, the tunnels will appear smooth as is sanded.

Nevada Dampwood Termite *Zootermopsis nevadensis*

Nevada Dampwood Termites are found primarily in Nevada, Idaho, California, Washington, and Oregon. This termite dwells in mountain regions and likes the high altitude and dry climate. This termite is attracted to wooden structures that are in contact with soil and built over or near water.

Even though their preference is a dryer climate, moist conditions are tolerated. This muncher also assists in the spreading of wood decaying fungi by carrying its spores on their bodies and in their stomachs. Soil contact is not necessary but will nest in fallen wood that has been buried.

Nevada Dampwood Termites do not like highly populated areas. But when these critters do infest a home they usually attack wood siding, fence posts, pilings, pond bridges, and downspouts.

Nevada Dampwood Termite swarmers are dark brown with wings, growing up to 3/4″ long. The soldier termites have long flat heads with straight sides.

Workers have large abdomens and are light brown. Nymphs are a creamy color with a spot on their stomachs (digesting food).

Occasionally termite control experts will find a home infestation. It usually occurs in the wood siding of a home where the siding touches the ground, around downspouts, and in fence posts. They will not normally attack homes because the moisture content is too low.

Swarming

The Nevada Dampwood Termite swarms in the spring, summer and early fall. When swarming, they seek out wood with a high moisture content to start new colonies. The most obvious sign of infestation is discarded wings and alates found in your home or around your property.

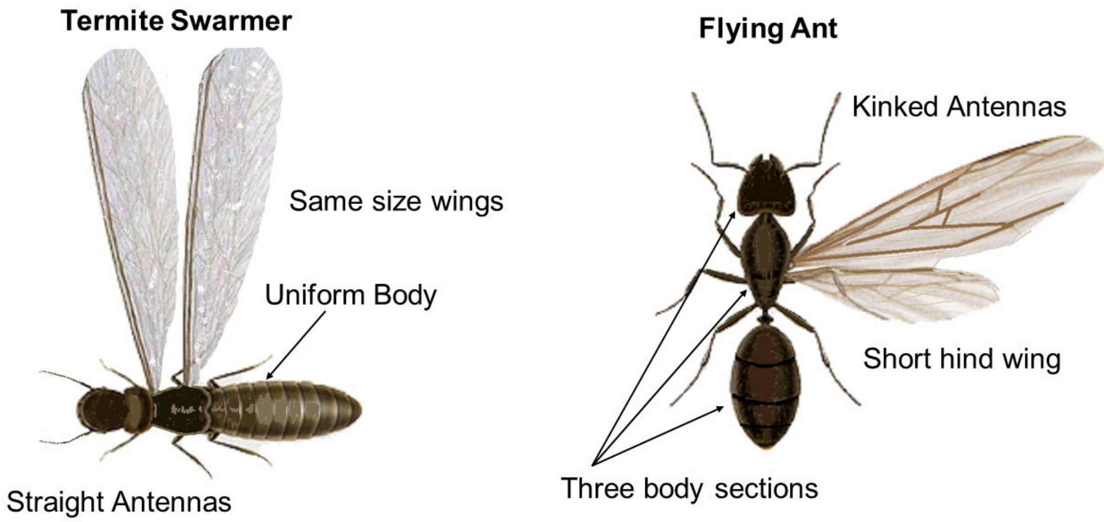
Upon inspection of your home, if you find an infestation you can do certain things that will discourage their occupation.

- Remove wood piles that are around your home
- Replace infested wood with pressure treated timber
- Fix any leaks around your home

Summary

Nevada dampwood termites have three primary castes: nymphs, reproductives and soldiers. The reproductive, also known as alates, are often up to ¾-inches long and have dark-brown wings and dark-brown bodies.

Nymphs are cream colored and soldiers have brownish-colored heads with very large mouthparts that are used to help defend the colony from predators.



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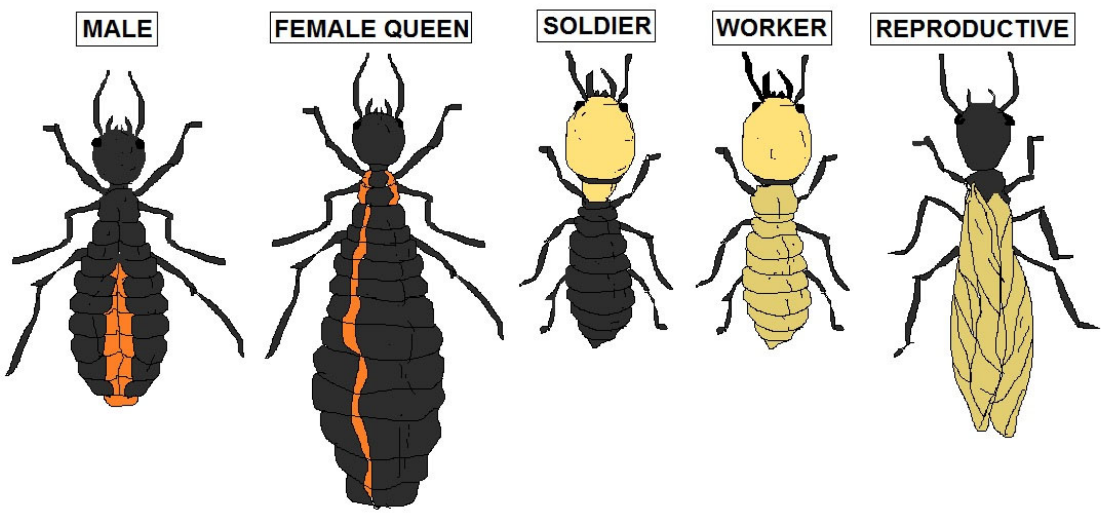
SWARMER TERMITE & FLYING ANT



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TERMITE CASTE

Formosan Subterranean Termites Sub-Section

Introduction

The Formosan subterranean termite, Coptotermes formosanus (Shiraki), was first described as a species in 1909 from specimens collected on the Asian island of Formosa. It is now generally accepted that the termite is native to China and Formosa. This termite is considered a serious structural pest whenever it occurs. The Formosan subterranean termite has been found in Japan, Sri Lanka, Philippines, Guam, Hawaii, South Africa and the continental United States. Although officially reported in Hawaii in 1913, newspaper reports indicate that the termite was on the island as early as 1869.

The first report of the Formosan termite in the continental U.S. was from a Houston shipyard in 1965. It was reported in Louisiana in 1966 and Charleston, S.C. in 1967, although specimens collected in Charleston in 1957 indicate that the termite was introduced nearly ten years earlier. The Formosan termite has also been identified in Broward and Dade counties in Florida (1980-3); Mobile, Lee, and Baldwin counties in Alabama (1985-87); Memphis, TN (1985); North Carolina (1990); San Diego, CA (1991); and Atlanta, GA (1993). It is believed that these infestations were transported in infested building or plant materials from areas where the termites were well established.

Biology

As with the native subterranean termites, Formosan termites initiate new colonies by sending out winged reproductives (alates) from established colonies. The Formosan swarms occur from May to July depending on the area that receives constant humidity and warmth. Formosan termite swarms occur from dusk to midnight and the alates are attracted to lights. After a short flight (usually not more than 20-50 yards) the alates lose their wings, pair off, and seek a small crevice in moist wood to begin the new colony.

It takes 3-5 years for a mature colony to develop from a queen, which lays approximately 2,000 eggs/day. Mature colonies can have a population of 10 million foraging workers, soldiers, a primary queen, and several secondary reproductives. The foraging territory of a mature colony can occupy several thousand square feet.

Destructiveness

The Formosan termite is known to attack over 50 species of living plants as well as structural lumber. A survey in New Orleans showed that 10% of the utility poles in the city are infested with the Formosan termite. This termite is often described as aggressive in both its feeding habits and foraging tenacity.

They cannot eat through concrete but have been known to attack non-cellulose materials like plastic, asphalt, and thin sheets of soft metal. Although laboratory studies indicate that the individual Formosan termite eats slightly more wood than the native subterranean termites the larger colony populations found with this termite can cause severe structural damage to unprotected homes in 2 years.

The Formosan subterranean termite usually enters structures from colonies maintaining contact with ground to provide the necessary moisture requirements. However, the Formosan termite, more than the native subterranean species, is able to initiate colonies which have no ground contact (aerial colonies).

Recognition

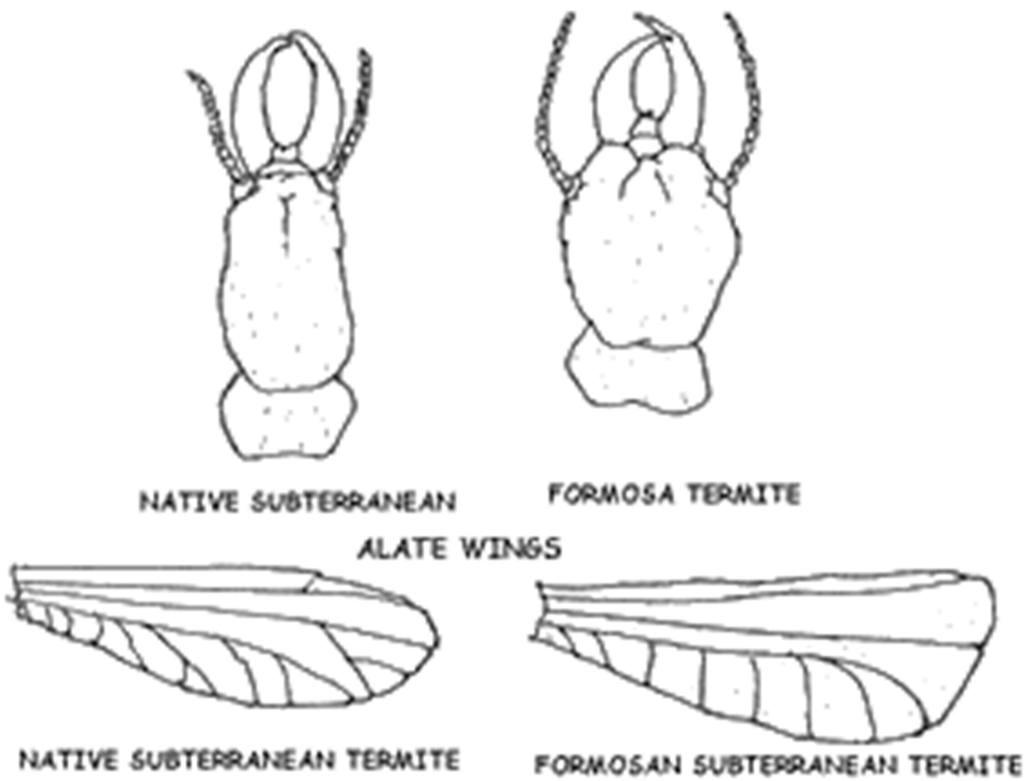
Damage

The damage caused by the Formosan termite is similar in many respects to the damage done by native subterranean termites. Termite feeding will follow the grain in a piece of structural lumber, but the Formosan termite is more likely to feed on both the summer and spring wood, leaving a larger hollow space in the damaged lumber. Native subterranean termites usually fill their feeding galleries with soil and excrement; whereas the galleries of the Formosan termite are cleaner--practically soil free and covered with whitish spots.

In severe infestations, Formosan termites will fill hollow spaces, or even wall voids, with a combination of termite excrement, macerated wood, saliva and soil. This material, called carton, can be used by the Formosan termite to form nest-like structures and is unique to the Formosan termites. Carton nests are constructed in or near the feeding site and a single colony may have several of these auxiliary nests – each containing secondary reproductives.

Insect Identification

Three caste forms of subterranean termites are often found at the site of an infestation--alates, soldiers and workers. Only the alates and soldiers can be used for identification.



SOLDIER TERMITE COMPARISON

Alates - Below is listed a comparison of Formosan alates and the three common native subterranean species.

	Formosan	R. flavipes	R. virginicus	R. hageni
Body Size	12-15 mm (0.5 – 0.6 in.)	8-10 mm (0.3 – 0.4 in)	4.5-5 mm (0.1 – 0.2 in)	4.5-5 mm (0.1 – 0.2 in)
Body Color	Light yellow-brown	Black	Black	Light yellow-brown
Wings	Covered with fine hairs	No hairs	No hairs	No hairs
Wing size	> 11 mm (0.4 in)	8-9 mm (0.3 in)	6.5-7.5 mm (0.25 in)	6-7 mm (0.2 in)
Flight times	May – July Night	Feb – April Day	May-June Day	August Day
Antennal Segments	Greater than 20	Less than 20	Less Than 20	Less than 20

Soldiers
Soldiers of the Formosan termite have an oval-shaped head compared to the oblong shape of the native subterranean soldiers. In addition, the Formosan soldiers have a well-developed fontanelle which forms a tube-like structure on the front margin of the head just above the mandibles. When disturbed, the soldiers emit a milky white fluid from this opening; whereas native termite soldiers do not eject any noticeable substance. The proportion of soldiers to workers in native subterranean termite colonies is approximately 1-2 to 100 (1-2%), in contrast to the Formosan termite colony which contains 10-20 soldiers for every 100 workers (10-20%).

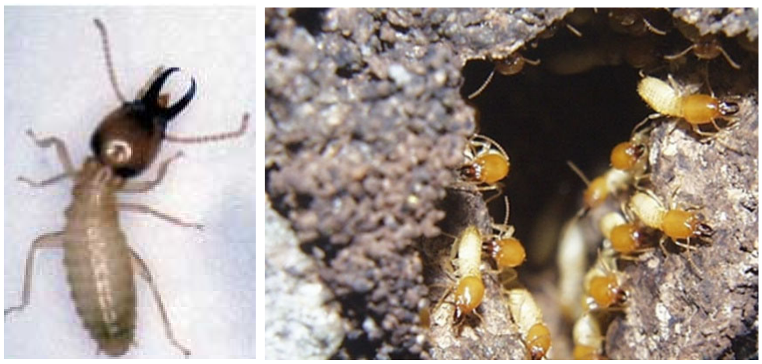
Damage
Subterranean termites most commonly live in the soil where they can avoid temperature extremes and obtain the moisture essential to their existence. Rather than building a discreet nest like their tropical cousins, subterranean termites construct numerous scattered nursery areas where reproductives are found together with piles of eggs and young termites. These nursery areas can be in buried stumps, logs, dead roots or pieces of lumber left in the backfill after building construction. Nursery areas can also be found in the wood of structures. These areas can be as far down as 3 to 6 m below ground level.

Because subterranean termites can get moisture from the soil, they can attack any dry wood or other source of cellulose within foraging distance of the colony. Besides wood structures, subterranean termites will attack untreated fence posts and attached boards, utility poles, and any other food sources such as cardboard, paper, or fiberboard in, on, or close to the ground.

They prefer to feed on the softer spring growth of infested wood, leaving the harder summer wood and a paper-thin outer shell of wood. Termite nursery areas located under sub-floors or concrete slabs near furnaces, water heaters or other sources of heat can remain active during the winter. Where a wood source is not in contact with the soil, workers will build earthen '*shelter tubes*' over concrete foundation walls or in cracks in the concrete through which they can travel to and from the food source and soil moisture.

Occasionally, the tubes can be built downward from a wood member to the ground. The tubes provide protection from predators, especially ants, which are mortal enemies of termites.

Besides gaining entry via wood touching or close to the ground, termites can enter through cracks in concrete foundations and slabs, and through spaces around utility pipes cut through cement foundations. Workers have been observed following the roots of spreading junipers under landscape cloth covered with bark mulch or wood chips. This environment also provides protection from ants and high temperatures. Workers will also feed on wood chips in contact with soil.



Formosan termite left and a colony, right.

The Formosan Infestation Map is a made possible through the cooperation of PCOs, state associations, state regulatory officials and termite researchers. It is continuously updated, so please return to the LIPCA web site often.

Assessing Wood Damage

Termite damage to the wood's surface often is not evident because termites excavate galleries within materials as they feed. Wood attacked by subterranean termites generally has a honeycombed appearance because termites feed along the grain on the softer spring growth wood. Their excavations in wood often are packed with soil, and fecal spotting is evident.

When inspecting for termites, it is useful to probe wood with a knife or flat blade screwdriver to detect areas that have been hollowed. Severely damaged wood may have a hollow sound when it is tapped.

Again, Subterranean termites do not reduce wood to a powdery mass, and they do not create wood particles or pellets, as do many other wood-boring insects.

Mass Emergence
The mass emergence of winged termites in the spring is often the first sign of an infestation. In the majority of cases, they emerge in homes near sources of heat - furnaces or water heaters. The appearance of winged termites means that the infestation has been around for at least 3 or 4 years. Therefore it is likely some damage has already been done, so it is important to find where the termites have been feeding, how much damage has been done, and how much repair is needed.

A qualified professional termite control service should be hired to apply an appropriate termiticide to protect the building from further damage. Other means of detecting infestations include knocking on walls, floors, sub-floor wood, joists, etc. and listening for the tapping of soldiers, and looking for shelter tubes on the outside of the building and under the sub-floor.

Because subterranean termites have a constant demand for water, one should closely examine areas near moist soil, such as below dripping outside faucets, leaking underground sprinkler pipes and nozzles, and below downspouts.

Where damage or termites are suspected, prod with a sharp narrow implement to check the soundness of the supporting wood structure. The detection of termite infestations is best left to professionals who have the experience to do it thoroughly and accurately. Termites can enter a building from one or more points so it is important to locate all points of entry for control purposes.

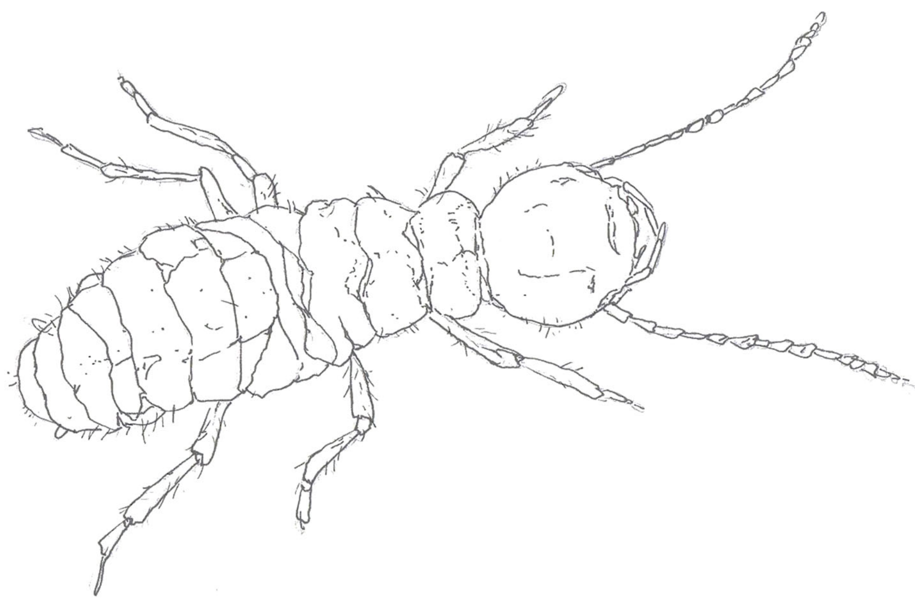
Outdoors, termites can be detected by driving wooden stakes into the ground at varying distances from buildings and other wooden structures. Examine the stakes every 3 months for termites or signs of their feeding damage.

Evidence of Termite Infestations

1. Wood damaged by subterranean termites can be readily penetrated with a screwdriver, ice pick, or knife. The wood easily breaks apart, revealing mud tubes attached to wood galleries or tunnels in an irregular pattern. The tunnels may contain broken mud particles with fecal materials. In the case of an active colony, white termites may be found in infested wood.

2. The presence of winged males, females, or their shed wings, particularly when the adults fly inside the building, indicates an infestation in the building.

3. Another indication is the presence of mud or shelter tubes extending from the ground to woodwork or on foundation walls. Workers travel periodically via shelter tubes to their colony to obtain moisture and perform feeding duties. Workers build mud or shelter tubes from soil and wood particles, and coat them with a glue-like substance that they secrete. Each mud tube is about the diameter of a lead pencil.



SUBTERRANEAN FORMOSAN TERMITE

How Old is the Damage?
Based on normal feeding activity, it takes 3 to 8 years to cause appreciable damage to a structure. There have been some predictions that, under ideal conditions, a termite colony of 60,000 workers may consume a one-foot length of 2" x 4" pine in 118 to 157 days. In the United States, the extent of damage may be less because of a reduction in feeding activity during the cold season.

Termites in Palm Trees

Termites eat palm trees because they contain high cellulose concentration and fiber. When termites attack a palm tree, they will start eating it from the bottom where the roots are attached to the ground. They will live inside the tree and eat it for quite some time and you will only notice the damage after it is severe.

Subterranean termites will build **the mud tube on the trunk**

A sign of termites in a palm tree, includes a thin wall of soil or mud tubes, a mound near the base of the tree, but not always, depending on the soil and tree's location to concrete or street. You will also notice frass or termite waste that looks like dust around the palm tree. The frass will be in large amounts because there will be plenty of food for the termites to feed on. The palm tree will eventually fall down because termites will also have eaten its root and nothing can save the tree at this point.

Treatment Options

The methods of termite treatment inside a living tree are pretty much the same as the ones for the infested house or timber.
So, here's what you can do:

- **termiticide barrier**;
- **foam or liquid termiticide injection**;
- **baiting**.

The most popular method of getting rid of the termites in a living tree is **to treat the soil around the infected tree**, to form a protective barrier.

Termidor or Premise Treatments
Some of the termiticide, that can be used for this treatment just repel the insects, and are more of a preventive measure, while the others, such as Termidor or Premise, have no smell or taste, so they do not keep termites away. Instead, they have the poison of the delayed action, that the foraging workers bring inside the nest, after passing through the treated soil, and it kills the whole colony in a matter of days.

You'll need to dig a trench around the tree base in 3-foot radius and pour the insecticide in the solution needed into it. Usually, the strong termiticides, that has Fipronil or other hazardous chemical as the active ingredient should be used

Sometimes the healing of the tree requires wrapping it in special material that keeps the insects and fungi away and gives the palm some time to recover. It is best to call an arborist to save the tree.

Cutting Down a Tree with Termites
Often by the time a pesticide applicator is called, the damage is too great. The only thing to do is spray the tree and hope for the best, but many times, the tree needs to be cut down and disposed of. Before you cut down a termite infested tree, you need to inspect if the damage has been spread to those that are around it. If the area is clear, spray a termite resistant i.e. liquid termiticide to the rest.

Spraying a liquid termiticide will prevent termites from infesting other live trees that are growing around the infested one. The importance of spraying is that, when you cut down a termite-infested tree, it will fall down and crack because it is hollow and dry. Termites will then scatter all over the place and they will look for a new habitat.

Termites will crawl the other trees that are near to build and start a new colony. This is why you should take preventive measures to ensure that when the tree is cut, termites will not infest the other trees around. Those small pests are very organized and starting a colony is very easy for them.

If you are cutting down a tree with termites near the house, ensure you do so during the day. Use a rope to ensure that the tree falls away from the house. As you cut, use the rope to pull the tree so that when it falls, any scattered termites will not go into the house.

Tree limbs and leaves that touch the roof can attract termites to your home. These branches give termites a pathway from the ground to your house. Regular tree trimming can **dissuade termites from migrating to your roof**. Similar to tree limbs, mulch can draw termites closer to your home.

Signs of Termites in a Live Tree

Termites **rarely feed on live trees**, so if a tree is infested then it probably has a significant amount of dead or dry wood. This is common during a drought. If the tree is not sick or dry, then the culprits are likely Subterranean, Formosan or depending on your area, climate, drought, Dampwood termites which feed on certain species of live tree.

Live Trees that Termites will eat Depending on moisture	**Trees that Termites don't eat or don't perfer**
1. Oak trees, Red and White	1. Iroko tree
2. Deciduous trees - Ash, Alder, Maple, etc.	2. Greenheart
3. Conifers, Pine trees	3. Most Cypress trees
4. Black locust or the False acacia	4. Teak tree
5. Siberian pea tree	5. Some Cedars, some Redwoods
6. Gum trees	6. Niove tree
7. Osage-orange – Fruit Trees	7. Mahogany
8. Palm Trees	8. Black Walnut, Black cherry, Chestnut, Honey mesquite

- All depends upon the following conditions: weather, tree's health and tree's moisture. Termites will eat most redwoods but there are species that termites will avoid. Technically, redwood and many cedars are edible.

To identify and know if a live tree is being eaten by termites, you will check for their activities on the trunk and the roots. This is important because you can save a tree with termites if the signs are identified early enough.

Termites have different behaviors depending on the type and group. For example, the Formosan and the Drywood termites will eat a tree from inside while the Subterranean will feed on the trunk from outside. Here are some basic signs that will help you identify a termite infested tree:

1. Mud Tunnels on the Trunk

Mud tunnels on the tree trunk that look like tubes is a sign of subterranean termites on a tree. Those tunnels begin from the tree roots as they climb upwards. Those are made to protect them from the sun and anything that may attack them as they feed on the tree. They walk through those tunnels as they crawl on the tree. If you break those tunnels open, they will fall out in a rush towards cover because those termites do not like direct sunlight that dehydrates them. This is their natural way of survival. Those

2. Termite Holes in Trees
A sudden appearance of tiny holes on the tree's trunk with mud around it is a sign of termites' infestation in a tree. If the drunk is too dry, the holes may continue to grow. In some cases, there may be liquid-like sap or fluids oozing from the trunk through the holes. The liquid from termite holes on a tree trunk may be fresh or dried depending on how long the tree has been injured. If most of the liquid is fresh, then the infestation is at its early stages. If it is dried on the trunk, then this is a sign of a termite infestation on the tree that has lasted for a long time.

3. Termite Waste
Termite poop which is also known as frass can be found around an infested tree and this is a sign that termites are eating into the tree. To identify termite poop, look for tiny particles that look like powder with a color shade that is similar to the tree. If the tree is dark brown, the termite poop will also take the same color.

When this is found in plenty, it an indicating that the attack is serious. The tree trunk in also be covered by termite waste and this should be easy to identify. In most cases, the powdered termite poop will be spread around the tree. It is easy to notice them since they will be spread on the grass or the leaves of any plants growing around the tree.

4. Missing Bark
Missing bark is a telltale sign that a tree is infested with termites. Trees can lose bark for a variety of reasons, including disease and physical injury. But if you see large sections of missing bark, it could indicate a termite infestation. When termites infest a tree, they'll begin to devour it from the inside. Over time, the tree's structural integrity will become compromised, resulting in the loss of bark.

5. Termite Wings
Of course, termite wings are a characteristic sign that a tree is infested with termites. Subterranean termites, specifically, have wings that they'll drop after finding a suitable food source. Most termites drop their wings inside their food source, though you may find them outside of an infested tree as well.

6. Discolored Leaves
When termites are eating a live tree, they will soon derail and rob it of its natural nutrients. This will cause the tree to have discolored leaves. In most cases, some branches will start to fall off. If they break open, you will see termites and their eggs in it. Discolored leaves with dry branches is a sign that the termites have already eaten and damaged the tree. Severe cases like that cannot be reversed and it is better to bring the whole tree down. This will prevent further damage to other trees around that area.

Termite Inspection Procedure Sub-Section

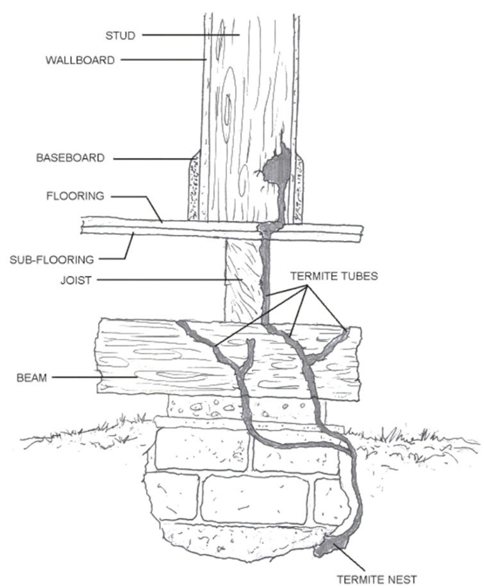
Applicators may be able to locate termite damage by probing wood with a screwdriver, ice pick, or knife. Start in the basement and use a bright flashlight. Look for mud tubes and the presence of swarmers. Termite damage/activity is often found during building remodeling or repair. Some agencies such as Farmers Home Administration (FHA), Veterans Administration (VA), Housing and Urban Development (HUD), and loan companies require termite inspections during real estate transfers. If necessary, seek help from professional pest control operators or experienced entomologists.

You as professional pesticide applicator should inspect exterior and interior foundation surfaces, particularly construction where wood is on or near the soil.

Mud tubes are solid evidence of termite activity. Other inspection sites are:

1. Wood construction in basement and crawl space (if present).
2. Sills, joists, support posts, basement window frames, wood under porches.
3. Hollow blocks, cracks in concrete or brick construction and expansion joints.
4. Scrap wood on ground, old tree stumps, fence posts, and exterior frames of basement windows.

Useful Information If Treatment is Necessary
If termite activity is suspected or found and an insecticide treatment is necessary, it is important to outline the plan of the building, indicating sites of termite activity and treatment procedures. Building owners/managers will require inspection reports and cost estimates. Always provide information about your chemical treatment procedures, repair of woodwork, warranties, copies of the insecticide label, and other pertinent information. Provide proof of liability insurance.



Control Objectives
The goal is to establish a continuous insecticide barrier between the termite colony (usually in the ground) and the wood in a building. Sometimes a secondary termite colony may exist above ground (in roof or other areas with a constant moisture supply) which requires additional treatment.

General Treatment Guidelines
Insecticide barriers are generally established during:

1. Pre-construction (during construction).
2. Post-construction (existing building). In an existing building, termite treatments may involve any of the following: a) mechanical alterations, and b) use of an insecticide for treating the soil, foundation, and wood.

In most cases, an untrained homeowner or building manager should not attempt a termite treatment.

Generally, termite treatments should be performed by professional pest control operators (PCOs), however, most termite chemicals or products are easily obtainable on Amazon or the Internet, thus providing access to chemicals to the public or handymen.

Termite ground or slab treatment requires special tools such as hammer drills, sub-slab injectors, rodding devices, high pressure pumps, a power supply, protective equipment. Several insecticides are registered in United States for termite control (Table 1). All of these insecticides control termites if properly applied. We will carefully study ground treatment in this course. The procedures described here are general guidelines, and the applicator must follow the insecticide label directions for dilution, application rate, and other relevant information.

Caution

1. Do not apply insecticides when soil is frozen or water-soaked (saturated). Frozen or saturated soil will not permit adequate absorption for even distribution of insecticide.
2. Do not permit humans and pets to contact treated surfaces until dry.
3. Before using insecticides for termite control, always read, understand and follow all label directions.
4. Keep all pesticides in original containers, out of reach of children and do not contaminate food, feed and water.
5. Do not plant garden food crops in treated soil.
6. Do not allow children and pets to play in treated soil.

Pre-Construction Treatment

Horizontal Barriers: In general, treat the footing trench with insecticide before pouring cement footings. After grading is completed, apply diluted insecticide to areas before pouring slab floors, slab-supported porches, patios, carports, and entrance platforms at the rate of 1 gallon per 10 square feet.

Vertical Barriers: Establish a chemical barrier in areas such as around the bases of foundations, plumbing, utility entrances, and backfilled soil against foundation walls. Treat crawl space areas either by rodding or trenching procedures. To produce a vertical barrier in soil, apply insecticide at the rate of 4 gallons per 10 linear feet per foot of depth. After treatment, cover the crawl space area with a layer of untreated soil or polyethylene sheeting.

Post-Construction Treatment

Do not apply insecticides until locations of radiant heat pipes, water pipes, sewer lines, and electrical conduits are identified.

Buildings requiring treatment generally fall into three categories:

a) building on slab construction,
b) building with crawl space, and
c) building with a basement.

There is a common belief that termites cannot penetrate slab foundations. Termites cannot penetrate solid concrete but they can enter through cracks as small as 1/64 of an inch.

Building on Slab
Controlling termite infestation in a building on a slab is especially difficult and hazardous. In this type of construction, heat ducts (pipes) are buried in the concrete and serious damage can occur when they are accidentally drilled for holes to inject insecticide solutions. Drilling through electrical conduits or plumbing imbedded in the floor is another problem.

Treat the exterior of the foundation by digging a narrow and shallow trench about 6 inches wide along the outside of the foundation. Apply the diluted insecticide to the trench and soil at the rate of 4 gallons per 10 linear feet. Cover treated soil in the trench with a thin layer of untreated soil. For an inside barrier, drill slab and space holes about 1 foot apart and 6 inches from the wall.

Sub-slab injector.

Using a subslab injector, inject insecticide through holes at the rate of 4 gallons per 10 linear feet. After application, plug all holes with mortar or any other special compound.

Table 1. Insecticides commonly used for subterranean termite control (check with your State for restrictions)

Brand or trade names	Generic or common names	Dilution rates	Manufacturers
Available to professional pest control companies			
Demon TC	cypermethrin	0.25%	ICI Chemical Co.
Dragnet FT	permethrin	0.5-1%	FMC Chemical Co.
Dursban TC	chlorpyrifos	0.5-1%	Dow-Elanco Co.
Equity	chlorpyrifos	0.5-1%	Dow-Elanco Co.
Ficam[a]	bendiocarb	0.25%	Nor-Am Chem. Co.
Prevail FT[b]	cypermethrin	0.3-0.6%	FMC Chemical Co.
Pyrfon 6	isofenphos	0.75%	Mobay Chemical Co.
Torpedo	permethrin	0.5-1%	ICI Chemical Co.
Tribute	fenvalerate	0.5-1%	Roussel Bio Corp.
Available to general public			
Orthoklor Soil Insect & Termite Killer	chlorpyrifos	0.5%	Chevron Chem. Co.
Black Leaf Termite Killer	chlorpyrifos	0.5%	Black Leaf Products
Chlor-Guard Termite Preventor	chlorpyrifos	0.5%	Security Products

[a]Registered for spot treatment only
[b]Registered for pre-construction treatment only

We will go more into detail in the Advance Treatment Section.

This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

Understanding Wood

Insects and mold can damage wood over time. To prevent that damage, wood is often treated with pesticides. Treated wood is commonly used to build telephone poles, road signs and marine pilings as well as decks, play structures and raised garden beds. Several wood preservatives are registered with the EPA, each with different uses and potential risks. Wood preservatives can extend the life of wood and reduce the need for forest resources, but proper use is important. Some preservatives can slowly leach into the surrounding soil or water. Sometimes, touching the wood can leave residue on exposed skin. Use the resources below to learn about selecting and using treated wood properly.

All measures that are taken to ensure a long life of wood fall under the definition wood preservation (timber treatment). Apart from structural wood preservation measures, there are a number of different (chemical) preservatives and processes (also known as timber treatment or lumber treatment) that can extend the life of wood, timber, wood structures or engineered wood. These generally increase the durability and resistance from being destroyed by insects or fungus. Wood in contact with the ground, or wood used above ground that often gets wet, is attacked by decay fungi and insects. Two common examples of this type of application are decks and fence posts. With the exception of naturally durable species such as redwood and cedar, wood used in these applications should be pressure treated with preservatives if it is expected to last more than a few years.

For several decades, consumers have been able to purchase pressure-treated wood at their local lumber yards. This type of treated wood, commonly called "green treated," was most likely pressure impregnated with a preservative called chromated copper arsenate (CCA). CCA is an extremely effective and durable treatment against both decay and insect damage. This relatively inexpensive preservative treatment has been used since the 1940s. Alternative preservative treatments are now available.

CCA

Wood industrially pressure-treated with approved preservative products pose a limited risk to the public, but should be disposed of properly. On December 31, 2003, the US wood treatment industry stopped treating residential lumber with arsenic and chromium (chromated copper arsenate, or CCA). This was a voluntary agreement with the United States Environmental Protection Agency. CCA was replaced by copper based pesticides, with exceptions for certain industrial uses. Industrial wood preservation chemicals are generally not available directly to the public and may require special approval to import or purchase depending on the product and the jurisdiction where being used. In most countries, industrial wood preservation operations are notifiable industrial activities that require licensing from relevant regulatory authorities such as EPA or equivalent. Reporting and licensing conditions vary widely depending on the particular chemicals used and the country of use.

Although pesticides are used to treat lumber, preserving lumber protects natural resources by enabling wood products to last longer. Previous poor practices in industry have left legacies of contaminated ground and water around wood treatment sites in some cases. In considering preservative treatment processes and wood species, the combination must provide the required protection for the conditions of exposure and life of the structure. All these factors are considered by the consensus technical committees in setting reference levels required by the American Wood Protection Association (AWPA, formerly American

Wood-Preservers' Association)) and ASTM International (formerly American Society for Testing and Materials).
Details are discussed later in this section. The characteristics, appropriate uses, and availability of preservative formulations may have changed after preparation of this course manual. For the most current information on preservative formulations, the reader is encouraged to contact the appropriate regulatory agencies, standardization organizations, or trade associations. Note that mention of a chemical in this section does not constitute a recommendation.

When using treated wood, keep these tips in mind:

- Make sure you select the proper type of treated wood for the job. Some treated wood and wood preservatives are restricted to specific uses.
- Consider wearing gloves when handling unsealed treated wood to reduce exposure to your skin.
- Consider wearing a dust mask while cutting treated wood to help prevent treated sawdust from being inhaled. Even untreated wood can irritate a person's airways.
- Never burn treated wood. Toxic chemicals can be released in the smoke.
- Consider using paint, varnish or some other type of sealant on treated wood as a barrier between the chemical and the surrounding environment.

Wood Destroyers Introduction Post Quiz

Termites

1. Which species of termites are the most destructive of all termite species, account for 95% of the damage?

2. Workers are creamy white, soft-bodied, wingless, and blind.
True or False

3. Flying ants and swarming termites are often difficult to distinguish when these insects are seen around residential and commercial buildings.
True or False

Termite Life

4. The single female can easily start a new colony on her own. Establishment of a colony is dependent upon the survival of both the queen in the nest site and that she has successfully mated.
True or False

Communication in the Colony

5. Western subterranean termite workers look like white or cream-colored ants. Swarmers are about 3/8-inches long (wings included), and their body is dark brown. They have two pairs of wings, and the front wings are larger than the hind wings. Soldiers have an orange, rectangular-shaped head with large pincher- like mouthparts that are used to fight off colony invaders.
True or False

6. Ants have one pair of transparent wings with many veins and are of equal length, and often have a light patch along the outer margin of the front wing, whereas the wings of termites are about equal in length (8-9 mm) and have many fine veins.
True or False

7. Western subterranean termites have acute survival instincts. If they are shaken up or disturbed, the termites often will abandon the associated area and move on to secretly cause damage in other areas in the building.
True or False

8. Which termite species termite's colonies are relatively small, with a few thousand members lacking the true worker caste, and there are often multiple colonies in the same structure?

9. Which termite species termite's colony consists of three castes: reproductives, soldiers and nymphs? Winged reproductive, or alates, are almost one-inch long and their color ranges from yellowish-brown to cinnamon-brown.

10. Which termite species does not build mud shelter tubes above the ground in order to reach wood?

Post Quiz Answers Wood Destroyer Introduction
1. Subterranean, 2. False, 3. True, 4. False, 5. True, 6. False, 7. True, 8. Drywood 9. Pacific dampwood 10. Desert Dampwood

Topic 7 - Termite and Wood Destroyer Management

Section Focus: You will learn the fundamentals of termite and related wood destroyer management and control techniques. At the end of this section, you the student will be able to understand and describe pest management, control and elimination techniques of wood destroyers. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Pest control professionals use a wide range of termite application equipment (sometimes called termite spray equipment) to prevent and treat termite infestations in homes.Termiticides, which control termite populations, come in both liquid and foam formulations. When choosing equipment and techniques for termiticide application, a professional will consider the type and concentration of product, as well as your home's construction and signs of infestation. Experts apply materials in a targeted manner, using the least amount of materials necessary for control – termiticides are not sprayed.

Conventional Pest Control Verses Integrated Pest Management

"Conventional" Pest Control

1. Chemical intensive
2. Emphasis on Killing pest directly
3. Largely reactive to pest outbreaks
4. Primary purpose of site visits is to apply more pesticide
5. General and overuse of pesticides
6. Less emphasis on prevention

Integrated Pest Management

1. Knowledge intensive
2. Emphasizes modification of conditions that favor pests
3. Systematic program of long-term pest control
4. Major purpose of most site visits is to inspect and monitor
5. Pesticide use is limited in terms of types, amounts and locations
6. Major emphasis on prevention of pest problems

Types of Pesticide Spectrums

Broad-Spectrum

A pesticide that is effective against many pest. An example of a broad-spectrum pesticide is methyl bromide, which is designed to control pests ranging from small insects and pathogens to larger weeds and rodents. The pesticide can be injected into the ground to kill organisms in the soil that might harm the plant while it is growing. It can also be pumped into warehouses or barns to kill pests that could harm the plant during storage or transport for sale.

Narrow-Spectrum AKA Target-Spectrum

Developed to kill specific organism types. An example of a narrow-spectrum pesticide is chitin inhibitors, which are chemicals that interact with chitin, a component of the exoskeleton of insects.

This pesticide inhibits the development of chitin and will eventually result in the death of the insect. The chitin inhibiting pesticide will only harm insects that have chitin in their exoskeletons and will not affect other insects.

Termiticide Examples

We will take a quick look at examples of termiticides used for soil treatment including cypermethrin, fipronil, fenvalerate, imidacloprid and permethrin. Any of these can be used to establish a chemical barrier that destroys or repels termites. Label directions for these materials should be followed closely for the concentration and rate of application to be used. The judgment and experience of the termite specialist is important when selecting the termiticide that best suits the particular type of construction and the soil conditions. Below are descriptions of the various products and classes of chemicals that can be used in termite control.

Termite Sprays
A tank and pump system is the primary means for applying liquid and foam termiticides. Termiticide is pumped from a tank through a long hose that can withstand high pressure. Nozzle attachments allow the termite control expert to customize the application based on the receiving material (soil or wood) and depth required to control the colony. Since this application is targeted to exact specifications, materials are not actually sprayed – they are applied in set amounts

Pyrethroids
The pyrethroids are a large family of modern synthetic insecticides similar to the naturally derived botanical pyrethrins. They are highly repellent to termites, which may contribute to the effectiveness of the termiticide barrier. They have been modified to increase their stability in the natural environment. They are widely used in agriculture, homes, and gardens. Some examples are bifenthrin, cyfluthrin, cypermethrin, deltamethrin, and permethrin.

They may be applied alone or in combination with other insecticides. Pyrethroids are formulated as emusifiable concentrates (EC), wettable powders (WP), granulars (G), and aerosols.

Certain pyrethroids exhibit striking neurotoxicity in laboratory animals when administered by intravenous injection, and some are toxic by the oral route.

Systemic toxicity by inhalation and dermal absorption are low, however—there have been very few systemic poisonings of humans by pyrethroids. Though limited absorption may account for the low toxicity of some pyrethroids, rapid biodegradation by mammalian liver enzymes (ester hydrolysis and oxidation) is probably the major factor responsible.

This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded.

No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

Most pyrethroid metabolites are promptly excreted, at least in part, by the kidney. In response to dermal exposure, some persons may experience a skin sensitivity called paresthesia. The symptoms are similar to sunburn sensation of the face and especially the eyelids. Sweating, exposure to sun or heat, and application of water aggravate the disagreeable sensations. This is a temporary effect that dissipates within 24 hours.

First Aid
For first aid, wash with soap and water to remove as much residue as possible, and then apply a vitamin E oil preparation or cream to the affected area. Paresthesia is caused more by pyrethroids whose chemical makeup includes cyano- groups: fenvalerate, cypermethrin, and fluvalinate. In addition to protecting themselves from future exposure, persons who have experienced paresthesia should choose a pyrethroid with a different active ingredient, as well as a wettable powder or microencapsulated formulation.

About These Pesticides
Pyrethrins and pyrethroids are insecticides included in over 3,500 registered products, many of which are used widely in and around households, including on pets, in mosquito control, and in agriculture. The use of pyrethrins and pyrethroids has increased during the past decade with the declining use of organophosphate pesticides, which are more acutely toxic to birds and mammals than the pyrethroids. This change to less acutely toxic pesticides, while generally beneficial, has introduced certain new issues. For example, residential uses of pyrethrins and pyrethroids may result in urban runoff, potentially exposing aquatic life to harmful levels in water and sediment.

Pyrethrins are botanical insecticides derived from chrysanthemum flowers most commonly found in Australia and Africa. They work by altering nerve function, which causes paralysis in target insect pests, eventually resulting in death.

Pyrethroids are synthetic chemical insecticides whose chemical structures are adapted from the chemical structures of the pyrethrins and act in a similar manner to pyrethrins. Pyrethroids are modified to increase their stability in sunlight.

Most pyrethrins and some pyrethroid products are formulated with synergists, such as piperonyl butoxide and MGK-264, to enhance the pesticidal properties of the product.

These synergists have no pesticidal effects of their own but enhance the effectiveness of other chemicals.

Pyrethrins, a single pesticide active ingredient, contain six components that have insecticidal activity: pyrethrin 1, pyrethrin 2, cinerin 1, cinerin 2, jasmolin 1, and jasmolin 2

Pyrethroids include:
Allethrin stereoisomers, Bifenthrin, Beta-Cyfluthrin, Cyfluthrin, Cypermethrin, Cyphenothrin, Deltamethrin, Esfenvalerate, Fenpropathrin, Tau-Fluvalinate, Lambda-Cyhalothrin, Gamma Cyhalothrin, Imiprothrin, 1RS cis-Permethrin, Permethrin, Prallethrin, Resmethrin, Sumithrin (d-phenothrin), Tefluthrin, Tetramethrin, Tralomethrin, and Zeta-Cypermethrin

Synergists include:MGK-264 and Piperonyl butoxide

Permethrin

General Information
Permethrin is a broad-spectrum pyrethroid insecticide. It is available in dusts, emulsifiable concentrates, smokes, ULV concentrates, and wettable-powder formulations.

The historical development of the synthetic pesticides called pyrethroids is based on the pyrethrins, which are derived from chrysanthemums. Pyrethrins are a "natural" environmental product that is of low toxicity to mammals. They are highly photolabile and degrade quickly in sunlight, and the cost of reapplying them has limited their widespread agricultural use. Pyrethroids have been synthesized to be similar to pyrethrins yet more stable in the environment. Evidence suggests that they have a very large margin of safety when used as directed by the label (Aldridge, 1990; Chen et al., 1991; Snodgrass, 1992).

Commercial pyrethroid products commonly use petroleum distillates as carriers. Some commercial products also contain OP or carbamate insecticides because the rapid paralytic effect of pyrethrins on insects ("quick knockdown") is not always lethal (Cheremisinoff and King, 1994). Pyrethroids are formulated as emulsifiable concentrates, wettable powders, granules, and concentrates for ULV application.

Borates

"Borate" is a generic term for compounds containing the elements boron and oxygen. Boron never occurs alone naturally but as calcium and sodium borate ores in several places in the world.

Borax and other sodium borates are used in numerous products such as laundry additives, eye drops, fertilizers, and insecticides. Though the mechanisms of toxicity are not fully understood, boron is very toxic to insects and decay fungi that commonly damage wood in structures. At low levels, however, boron is only minimally toxic, and perhaps beneficial, to humans, other mammals, and growing plants. Use of borate-treated wood for construction of homes and their wood-based contents appears to offer many advantages to today's environmentally sensitive world.

Unlike most other wood preservatives and organic insecticides that penetrate best in dry wood, borates are diffusible chemicals—they penetrate unseasoned wood by diffusion, a natural process. Wood moisture content and method and length of storage are the primary factors affecting penetration by diffusion. Properly done, diffusion treatments permit deep penetration of large timbers and refractory (difficult-to-treat) wood species that cannot be treated well by pressure.

The diffusible property of borates can be manipulated in many ways; suitable application methods range from complex automated industrial processes to simple brush or injection treatments. Application methods include momentary immersion by bulk dipping; pressure or combination pressure/diffusion treatment; treatment of composite boards and laminated products by treatment of the wood finish; hot and cold dip treatments and long soaking periods; spray or brush-on treatments with borate slurries or pastes; and placement of fused borate rods in holes drilled in wood already in use.

This publication contains pesticide recommendations that are subject to change at any time.

These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

Organophosphates and Carbamates Pesticides

Organophosphates are phosphoric acid esters or thiophosphoric acid esters. When developed in the 1930s and 1940s, their original compounds were highly toxic to mammals. Organophosphates manufactured since then are less toxic to mammals but toxic to target organisms, such as insects. Malathion, dibrom, chlorpyrifos, temephos, diazinon and terbufos are organophosphates. Carbamates are esters of N-methyl carbamic acid. Aldicarb, carbaryl, propoxur, oxamyl and terbucarb are carbamates.

Although these pesticides differ chemically, they act similarly. When applied to crops or directly to the soil as systemic insecticides, organophosphates and carbamates generally persist from only a few hours to several months. However, they have been fatal to large numbers of birds on turf and in agriculture, and negatively impacted breeding success in birds. Many organophosphates are highly toxic to aquatic organisms.

These are two very large families of insecticides. Indeed, they have been the primary insecticides for the past 25 to 30 years. They range in toxicity from slightly to highly toxic. They are formulated in all kinds of ways from highly concentrated emulsifiable concentrates (ECs) to very dilute granular (G) formulations.

These insecticide families are similar in their modes of action—they are all nervous system poisons. Insects and all other animals, including humans, have nervous systems that are susceptible. Both insecticide families are efficiently absorbed by inhalation, ingestion, and skin penetration. To a degree, the extent of poisoning depends on the rate at which the pesticide is absorbed.

Organophosphates break down chiefly by hydrolysis in the liver; rates of hydrolysis vary widely from one compound to another. With certain organophosphates whose breakdown is relatively slow, significant amounts may be temporarily stored in body fat. The organophosphates and carbamates replaced the chlorinated hydrocarbons (e.g., chlordane, aldrin, and heptachlor) for all uses, including termite control. Examples of organophosphates are chlorpyrifos for termite control and diazinon for other household pests. An example of a carbamate is carbaryl, also used for household and lawn pests.

How can people be exposed to organophosphate and carbamate pesticides?
People can be exposed to organophosphates and carbamates pesticides through accidental exposure during use. People can accidentally inhale the pesticides if they are in an area where they were recently applied. The chemicals can be ingested with food or drinks that are contaminated.

How can these pesticides exhaust affect my health?
Acetylcholinesterase is an enzyme found in the nervous system, red blood cells and blood plasma. These pesticides damage nerve function by acting as acetylcholinesterase inhibitors in the nervous system.

Breathing
Short-term exposure can produce muscle twitching, headache, nausea, dizziness, loss of memory, weakness, tremor, diarrhea, sweating, salivation, tearing, constriction of pupils, and slowed heartbeat.

Long-term exposure can produce delayed neurotoxicity, such as tingling and burning in the extremities. This delayed neurotoxicity can progress to paralysis and is seldom reversible. Damage to the liver, kidney, immune system and bone marrow may occur. Some carbamates are also suspected carcinogens.

What should I do if exposed to these pesticides?
If you think you were exposed to these pesticides, contact your doctor.

Is there a medical test to show whether I was exposed to these pesticides?
The level of cholinesterase activity in red blood cells or plasma helps physicians determine exposure to these pesticides.

However, other chemicals or disease states can alter acetylcholinesterase activity. Urine or blood tests only apply if a person was exposed to a large quantity. Persons who will use these pesticides regularly should ask their physician to establish a baseline value prior to prolonged use, followed by monthly monitoring.

Acute Toxicity and Acute Effects
Acute toxicity of a pesticide refers to the chemical's ability to cause injury to a person or animal from a single exposure, generally of short duration. The harmful effects that occur from a single exposure by any route of entry are termed "acute effects." The four routes of exposure are dermal (skin), inhalation (lungs), oral (mouth), and the eyes. Acute toxicity is determined by examining the dermal toxicity, inhalation toxicity, and oral toxicity of test animals. In addition, eye and skin irritation are also examined.

Organophosphate Insecticides
Organophosphate insecticides include chlorpyrifos, diazinon, dimethoate, disulfoton, malathion, methyl parathion, and ethyl parathion. The carbamate compounds include carbaryl, carbofuran, methomyl, and oxamyl. Organophosphates and carbamates inhibit the enzyme cholinesterase, causing a disruption of the nervous system. All life forms with cholinesterase in their nervous system, such as insects, fish, birds, humans, and other mammals, can be poisoned by these chemicals.

Pesticide Poisoning
Insecticides cause the greatest number of pesticide poisonings in the United States. The most serious pesticide poisonings usually result from acute exposure to organophosphate and carbamate insecticides.

Seeking Medical Attention 1-800-222-1222
If you are having symptoms but are unsure if they are pesticide related, at least notify someone in case your symptoms become worse. Nevertheless, when symptoms appear after contact with pesticides, you should seek medical attention immediately. At this time, call the **National Poison Center at 1-800-222-1222** for guidance on the proper response to your symptoms. This number will direct your call to the nearest poison center, which is staffed on a 24-hour basis.

Pyrroles

Chlorfenapyr is the only termiticide from the pyrrole family of chemistry and is active primarily as a stomach poison with some contact activity. It is also non-repellent to termites. Chlorfenapyr is registered as a termiticide under the tradename Phantom®. Chlorfenapyr acts on the mitochondria of cells and uncouples or inhibits oxidative phosphorylation, preventing the formation of the crucial energy molecule adenosine triphosphate (ATP). As a result, energy production in the cells shuts down, resulting in cellular and, ultimately, termite death.

This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

TAURUS SC – FIPROLES EXAMPLE

Fiproles (or Phenylpyrazoles)

Fipronil is the only insecticide in this new class, introduced in 1990 and registered in the U.S. in 1996. It is marketed as a termiticide under the tradename Termidor®. This termiticide is a non-repellent material with contact and stomach activity. Fipronil works by blocking the gamma-aminobutyric acid (GABA) regulated chloride channel in neurons, thus disrupting the activity of the insect's central nervous system.

Table 1. Insecticides commonly used for subterranean termite control (check with your State for restrictions)

Brand or trade names	Generic or common names	Dilution rates	Manufacturers
Available to professional pest control companies			
Demon TC	cypermethrin	0.25%	ICI Chemical Co.
Dragnet FT	permethrin	0.5-1%	FMC Chemical Co.
Dursban TC	chlorpyrifos	0.5-1%	Dow-Elanco Co.
Equity	chlorpyrifos	0.5-1%	Dow-Elanco Co.
Ficam[a]	bendiocarb	0.25%	Nor-Am Chem. Co.
Prevail FT[b]	cypermethrin	0.3-0.6%	FMC Chemical Co.
Pyrfon 6	isofenphos	0.75%	Mobay Chemical Co.
Torpedo	permethrin	0.5-1%	ICI Chemical Co.
Tribute	fenvalerate	0.5-1%	Roussel Bio Corp.
Available to general public			
Orthoklor Soil Insect & Termite Killer	chlorpyrifos	0.5%	Chevron Chem. Co.
Black Leaf Termite Killer	chlorpyrifos	0.5%	Black Leaf Products
Chlor-Guard Termite Preventor	chlorpyrifos	0.5%	Security Products

[a]Registered for spot treatment only
[b]Registered for pre-construction treatment only

We will go more into detail in the Advance Treatment Section.

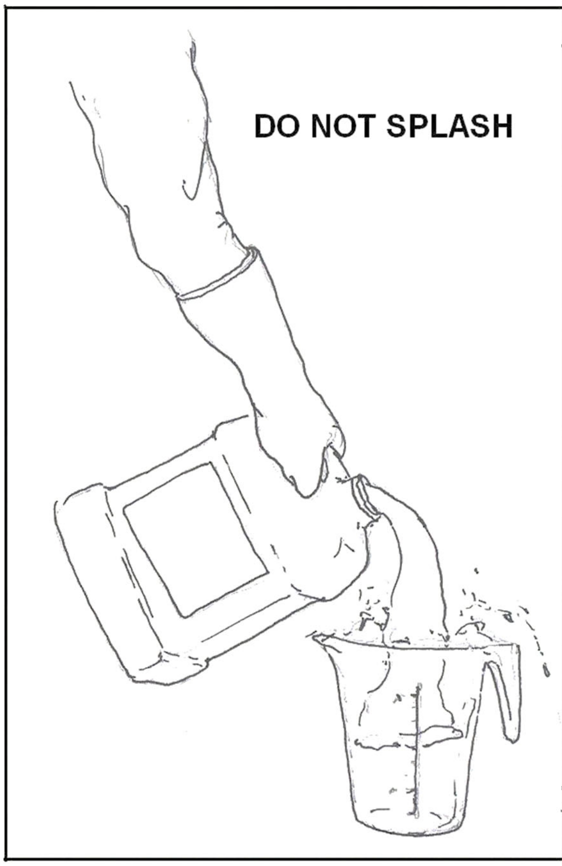
This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

Signs and Symptoms

Acute Exposure for Insecticide Active Ingredients

Active Ingredient	Brand Name	Signs and Symptoms
Acephate (organophosphate)	Orthene	Headache, excessive salivation and tearing, muscle twitching, nausea, diarrhea. Respiratory depression, seizures, loss of consciousness. Pinpoint pupils.
Aldicarb (N-methyl carbamate)	Temik	Malaise, muscle weakness, dizziness, sweating. Headache, salivation, nausea, vomiting, abdominal pain, diarrhea. Nervous system depression, pulmonary edema in serious cases.
Carbaryl (N-methyl carbamate)	Sevin	Malaise, muscle weakness, dizziness, sweating. Headache, salivation, nausea, vomiting, abdominal pain, diarrhea. Nervous system depression, pulmonary edema in serious cases.
Chlorpyrifos (organophosphate)	Dursban	Headache, excessive salivation and tearing, muscle twitching, nausea, diarrhea. Respiratory depression, seizures, loss of consciousness. Pinpoint pupils.
Endosulfan (organochlorine)	Thiodan	Itching, burning, tingling of skin. Headache, dizziness, nausea, vomiting, lack of coordination, tremor, mental confusion. Seizures, respiratory depression, coma.
Malathion (organophosphate)	Cythion	Headache, excessive salivation and tearing, muscle twitching, nausea, diarrhea. Respiratory depression, seizures, loss of consciousness. Pinpoint pupils.
Methyl Parathion (organophosphate)	Penncap-M	Headache, excessive salivation and tearing, muscle twitching, nausea, diarrhea. Respiratory depression, seizures, loss of consciousness. Pinpoint pupils.
Phosmet (organophosphate)	Imidan	Headache, excessive salivation and tearing, muscle twitching, nausea, diarrhea. Respiratory depression, seizures, loss of consciousness. Pinpoint pupils.
Pyrethrins (natural origin)		Irritating to skin and upper respiratory tract. Contact dermatitis and allergic reactions--asthma.

Pyrethroids (synthetic pyrethrin)	Cypermethrin, permethrin	Abnormal facial sensation, dizziness, salivation, headache, fatigue, vomiting, diarrhea. Irritability to sounds or touch. Seizures, numbness.



Insect Growth Regulators – Part 2

An insect growth regulator (IGR) is a synthetic chemical that mimics insect hormones. Hormones regulate a wide array of body and growth (physiological) functions. IGRs may interfere with molting, pupal emergence, or body wall formation. IGRs are often specific for an insect species or a group of very closely related species. They often have delayed effects because they are taken into the insect and stored until the insect reaches the right growth stage. This may range from days to weeks or even months. For example, if the IGR stops the insect from molting and a given insect is exposed just after a molt, it would continue to function normally until the next molt before dying.

In the case of termite control, the slow action of the IGR allows the chemical to be widely spread throughout the colony as the termite workers feed and groom one another. IGRs are, in general, environmentally safe and have very low mammalian toxicity. Some examples are hexaflumuron, diflubenzuron, pyriproxyfen, and methoprene.

Biotermiticides

Biotermiticides — such as fungi, nematodes, bacteria, and so forth—still need further research and development to maximize their potential. Metarhizium anisopliae can be injected into galleries, infested walls, and other moist areas where the humidity accelerates the fungal growth. Several forms of nematodes are sold for termite suppression. Nematodes are applied to the soil or directly into mud tubes. As with all new methods of control, more research is needed to determine the advantages and limitations of such organisms.

Biotermiticide, which is derived from fungi, bacteria or nematodes, is injected into active gallery sites. It then develops on the infected foraging termites and spreads among the colony. Suitable temperature and moisture, early detection and avoidance are factors that determine this treatment's success. It may provide localized area control or, with optimum conditions, may suppress a colony.

Nematodes are roundworms, or threadworms (the Greek word nema means thread) in the phylum Nematoda. Some species live as parasites inside the bodies of insects and other organisms, often with no observable effect on the hosts. Others cause effects ranging from minor discomfort to disease and death.

Entomophilic nematodes have affinities for insect hosts. Entomopathogenic nematodes (EPN) produce observable deleterious effects.

Certain entomopathogenic nematodes (EPN) are efficient biological control agents that can be used against subterranean termites. That fact has been obscured by tests that emphasized soil-drench (inundative) treatment methods. Recent tests using EPN as inoculums in specially-designed nematode-optimized termite interceptors show that they reliably suppress even large, vigorous termite colonies.

Because EPN do not elicit complex avoidance reactions in termites exposed to them, repeated inoculations in such devices should succeed, over time, in eliminating termite colonies entirely. Furthermore, EPN should perform well as termite colony inoculants in all climates and environments suitable for termite propagation, without the need for exotic toxicant adjuncts.

Among the insect growth regulators are juvenile hormone analogs (JHA), juvenile hormone mimics (JHM) and chitin synthesis inhibitors (CSI). These products disrupt the termites by causing a specific response or behavior within the colony or by blocking the molting process. Remember that all insects, including termites, have an exoskeleton made primarily of chitin. In order to grow, they must periodically shed their chitinous exoskeletons and form new ones. This process is called molting. A chitin synthesis inhibitor slowly builds up in the termite and, the next time a molt should occur, prevents proper formation of the cuticle. IGRs are the slowest of the bait types but have greater impact on the colony.

In some cases, these agents are released into the soil and in other cases they are injected into the above-ground termite galleries. As with all new methods of control, more research is needed to determine the advantages and limitations of such organisms. Bacillus thuringiensis or B.t. is an example of a commonly used biological control agent.

Liquid Formulations
Liquid formulations are generally mixed with water, but in some instances labels may permit the use of crop oil, diesel fuel, kerosene, or some other light oil as a carrier. This section will present more detailed information about the common liquid pesticide formulations.

Aerosols (A)
These formulations contain one or more active ingredients and a solvent. Most aerosols contain a low percentage of active ingredients. There are two types of aerosol formulations: the ready-to-use type commonly available in pressurized, sealed containers and those products used in electric- or gasoline-powered aerosol generators that release the formulation as a “smoke” or “fog.”

Liquid Baits
An increasing number of insecticides and rodenticides are being formulated as liquid baits. Liquid rodenticides are mixed with water and placed in bait stations designed for these products. They have two major benefits. Liquid rodenticides are effective in controlling rodents, especially rats, in areas where they cannot find water. They are also effective in areas of poor sanitation where readily available food renders traditional baits ineffective.

Dry or Solid Formulations
Dry formulations can be divided into two types: ready-to-use and concentrates that must be mixed with water to be applied as a spray. This section will present more detailed information about the common dry or solid pesticide formulations. Dusts (D) Most dust formulations are ready to use and contain a low percentage of active ingredients (usually 10% or less by weight), plus a very fine, dry inert carrier made from talc, chalk, clay, nut hulls, or volcanic ash. The size of individual dust particles varies.

Granules (G)
Granular formulations are similar to dust formulations except granular particles are larger and heavier. The coarse particles are made from materials such as clay, corncobs, or walnut shells. The active ingredient either coats the outside of the granules or is absorbed into them. The amount of active ingredient is relatively low, usually ranging from less than 1 to 15 percent by weigh.

Foaming Agents
Foam formulations of soil-applied termiticides can deliver termiticide to areas difficult to reach with liquid formulations. Borates are foamed for application in wall voids. Foams penetrate into hard-to-reach cavities and voids, and they improve termiticide distribution in soils. The most difficult area to achieve uniform and continuous insecticide distribution is under slabs, where the termite control specialist is unable to see the actual deposition of the termiticide.

Foam applications can reduce the need for corrective treatments, especially under slabs. The liquid termiticide is combined with air to create uniform, small-diameter bubbles. The foam carries the liquid termiticide in the spaces between the bubbles.

As the foam breaks down it leaves a thin residue on the surfaces it had contact with. The fact that foam is less dense than liquid enables it to dispense uniformly. The foaming agent delays collapse of the bubbles, providing more time for the insecticide to reach desired areas. Underneath a slab, gravity deposits most of the liquid on the soil, with a small portion of the residue on other surfaces (such as the underside of a concrete slab) in the treated areas.

Foam treatments do not replace other soil applications (they supplement these applications so that gaps left by conventional treatments can be successfully treated. Foams are being used to treat—or retreat—critical areas such as unevenly filled porches, which liquids might not reach or cover uniformly. Foams may be used in initial treatments to ensure the most complete termiticide barrier in critical as well as hard-to-reach areas, thus reducing the treatment failures that may occur with the use of soil-applied termiticides alone.

Fumigation
Pests that can be treated with fumigation include drywood termites, Anobiid powder post beetles (usually in softwoods such as floor joists, etc.), Lyctid powder post beetles (sapwood of hardwoods such as moldings, cabinets, and flooring), and old house borers (sapwood of softwoods in beams, rafters, etc.). We will cover this more in the advanced section of the course.

Advantages of Fumigation
Fumigation has several advantages over other pest control procedures:
- Fumigants are usually quick acting and eradicate the pest.
- Fumigants diffuse through all parts of the structure or commodity being treated and thus reach pest harborages that cannot be reached with conventional pest control materials or techniques.

For certain pests/commodities, fumigation is the only practical method of control.

GREAT CARE WHEN FILLING WITH PESTICIDES

Disadvantages of Fumigation

For several reasons, fumigation may not be the best means of pest control:

- The control achieved through fumigation is temporary. There is no residual action from fumigants, and as soon as the fumigation is completed, the structure or commodity is susceptible to re-infestation.
- Fumigants are toxic to humans and special precautions must be taken to protect fumigators and the occupants of fumigated structures.
- Fumigants must be applied in enclosed areas, so application requires additional labor.
- Fumigation must not be attempted by one person. Additional labor is required.

Some commodities or pieces of equipment may be damaged by certain fumigants and must be either removed or protected.

- The special training required for all members of the fumigation crew adds to fumigation costs.
- Occupants of the structure being fumigated usually must vacate the building for a number of hours.
- This may be inconvenient.
- Fumigation requires special licenses and certification.

Termite Bait Application

There are several termite baits on the market that add to the arsenal of tools available for managing termite populations and protecting structures. Baits work on the principle that foraging termites will feed on a treated cellulose material, which eventually kills the termites and possibly the colony. The toxic material in the bait must kill slowly enough to allow foraging termites to return to the colony and spread the bait through food sharing (trophallaxis).

Because dead termites repel other termites, the toxic material also must kill slowly enough so that dead termites do not accumulate near the bait. Baits control a colony locally—either eliminating it or suppressing it to the point that it no longer damages a structure. To be successful, the products must be non-repellent, slow acting and readily consumed by termites.

Three main types of bait products are available:

- Ingested toxicants or stomach poisons.
- Biotermiticides or microbes.
- Insect growth regulators (IGRs).

Each type has unique features and is used differently in termite control programs. Ingested toxicants have the quickest effect, though dose dependency and learned avoidance may limit this type of product to termite reduction in localized areas.

Biotermiticides, derived from fungi, bacteria, or nematodes, are injected into active gallery sites. They then develop on the infected foraging termites and spread among the colony.

Suitable temperature and moisture, early detection, and avoidance are factors that determine this treatment's success. It may provide localized area control or, with optimum conditions, may suppress a colony.

Among the insect growth regulators are juvenile hormone analogs (JHA), juvenile hormone mimics (JHM), and chitin synthesis inhibitors (CSI).

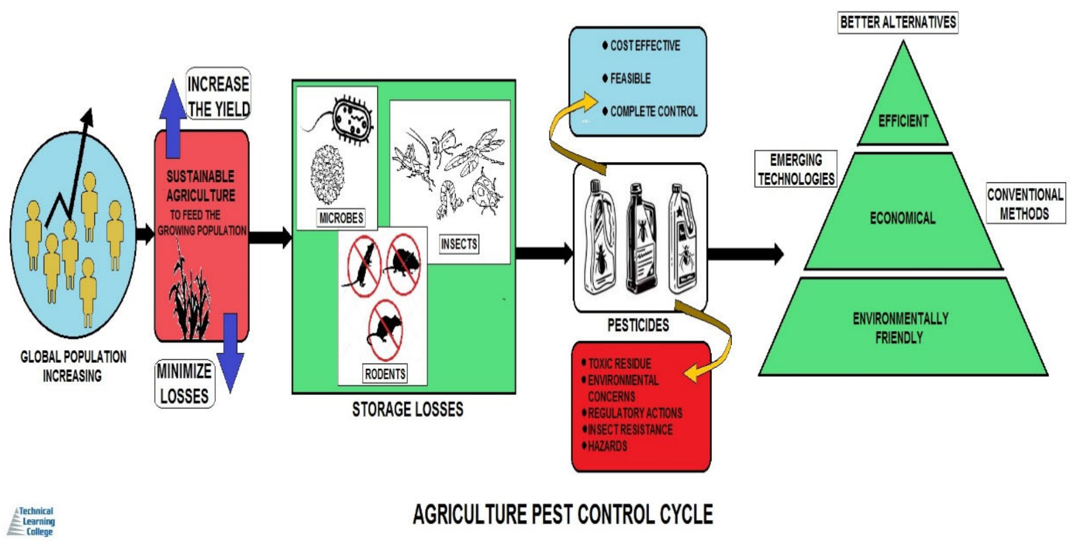
These products disrupt the termites by causing a specific response or behavior within the colony or by blocking the molting process.

Remember that all insects, including termites, have an exoskeleton made primarily of chitin. To grow, they must periodically shed their chitinous exoskeletons and form new ones. This process is called molting.

A chitin synthesis inhibitor slowly builds up in the termite and, the next time a molt occurs, prevents proper formation of the cuticle. IGRs are the slowest acting of the bait types.

Pesticide Safety Procedures

- Mix the chemical outdoors or in a well-ventilated area. Mix only the amount you need.
- Keep children and pets away from areas where you mix or apply pesticides.
- Never mix different pesticides.
- Never eat, drink or smoke when working with pesticides.
- Wear rubber gloves, a long sleeved shirt, long pants, foot protection, goggles, a hat and preferable a mask when mixing and applying pesticides. Remember that pesticides can be absorbed into your body through the skin, as well as orally and through inhalation.
- Always shower and shampoo after working with pesticides. Wash your work clothes separately from the family laundry.
- Always keep the pesticides in the original container.
- Store pesticides in a ventilated, dry and cool place, preferably locked and away from children.
- Use all the pesticide in the container, do not pour unused pesticides down the drain.
- Triple rinse empty pesticide containers and use the residue for application. If the pesticide is a solid, shake the bag to remove and use all product before you dispose of the container.
- Do not store anything in an empty pesticide container and do not reuse the container.



AGRICULTURE PEST CONTROL CYCLE

Commercial Baiting Products

Sentricon™ System
Sentricon™ System, developed by Dow AgroSciences for professional use, combines monitoring with the use of permanent stations. Stations are installed in areas where termites exist and around the perimeter of a structure and in the yard. Each station contains a wood stake and must be periodically monitored for termite activity.

After termites attack, the wood is removed and replaced with a bait tube. Termites from the wood must be transferred to the bait tube, which is left in the station until termite activity ceases. Then the bait tubes are replaced with new wood stakes and monitoring for new infestations resumes.

Thus, the Sentricon™ System protects property through an integrated program of monitoring, baiting when termites are present and resuming monitoring when termites are no longer present. The active ingredient in the Sentricon™ System is hexaflumuron, a chitin synthesis inhibitor. The philosophy behind the Sentricon™ System is that foraging pseudergates will feed on the bait, return to the colony and pass the bait to other colony members through trophallaxis. Dow AgroSciences claims that with the Sentricon™ System, colony elimination is possible.

FirstLine™ Termite Bait Stations
FMC Corporation manufactures bait stations for suppression of subterranean termite colonies. The FirstLine™ aboveground termite bait station is applied directly to active termite infestations. It is placed above ground, inside or outside, at the leading edge of active termite mud tubes.

Another product, the FirstLine™ GT in-ground bait station, is placed in the ground in areas conducive to termite attack and acts as a first line of defense against termite invasion of a structure. There are two types of these in-ground bait stations. One type has wood stakes for monitoring the presence of termites. The other type has cardboard treated with sulfluramid. Bait stations are placed in areas where termites are present or very close to monitoring stations that have been attacked by termites.

The active ingredient in FirstLine™ termite bait stations is sulfluramid, a slow-acting stomach poison. The philosophy behind the FirstLine™ products is that many termites will feed on the bait and over time will die.

Research with these bait stations demonstrates that reduction of the termite population is possible, but not elimination. FMC Corporation also markets Interceptor™, an on-the-wall application. This product is placed over a termite tube. The tube is broken open to allow termites to have access to the bait. The active ingredient is sulfluramid.

Exterra® Termite Interception and Baiting System
Ensystex Incorporated manufactures a termite baiting system called Exterra® Termite Interception and Baiting System. The in-ground stations are designed to permit visual inspection without removing or disturbing the stations. The chitin synthesis inhibitor diflubenzuron (Labyrinth®) is the active ingredient in the bait matrix, a shredded paper towel material.

Subterfuge® Termite Bait
BASF manufactures Subterfuge® termite bait with hydramethylnon as the active ingredient mixed into bait matrix. This baiting system places the active ingredient in the ground at the same time the station is placed in the ground. Hydramethylnon is a member of the amidinohydrazone family of chemistry and is primarily active as a stomach poison. It is also non-repellent to termites. It works on the mitochondria of cells and ultimately shuts down energy production, resulting in death in a manner similar to chlorfenapyr.

BioBlast™
An example of a biotermiticide is BioBlast™, manufactured by EcoScience. BioBlast™ is an EPA registered wettable powder containing live spores of the insect killing fungus Metarhizium anisopliae. This product is injected into the termite galleries. The spores germinate, penetrate the cuticles of termites and kill them. Spores are carried throughout the colony in a manner known as “horizontal transfer.” BioBlast™ controls termites in localized areas if conditions are right for the fungus to grow.

CARRY THE SDS AT ALL TIMES

Bait Technology

Baits

Bait technology uses wood or a cellulose matrix favored by termites that is impregnated with a slow-acting toxic chemical. Termite workers feed upon the bait and transfer it to other colony members by grooming or trophallaxis, eventually reducing or eliminating the entire colony. Termites are not site-specific, but rather, they forage among various food sites, which results in the bait being encountered by many colony members. The toxicant necessarily is slow acting because termites tend to avoid sites where sick and dead termites accumulate.

Typically, in-ground stations are inserted in the soil next to the structure and near known or suspected sites of termite activity. In-ground stations often initially contain untreated wood that serves as a monitoring device. The monitoring wood is replaced with the toxicant once termites have been detected feeding on it. In addition, aboveground stations may be installed inside or on the structure in the vicinity of damaged wood and shelter tubes. Aboveground stations initially contain bait.

It is very important that bait systems are properly installed and diligently serviced. Monthly inspections of a baiting system usually are necessary, except during inclement winter weather. Successful termite baiting necessitates proper monitoring and maintenance of the stations. Baits work much more slowly than soil termiticides, and the homeowner should be aware of the possibility of a lengthy baiting process. Several months or more may elapse before the termites locate stations, then termites must feed on sufficient amounts of the toxicant.

An often-cited advantage of termite baits is that they are "environmentally-friendly" because they use very small quantities of chemical and decrease the potential for environmental contamination. In addition, bait application causes little disruptive noise and disturbance compared to soil treatments. Furthermore, baits can be used in structures with wells or cisterns, sub-slab heating ducts, and other features that may preclude a soil treatment. Baits are often used in sensitive environments.

A number of baits have been marketed to control termites. Bait products that are available for licensed pest management professionals include the Sentricon® Termite Colony Elimination System (hexaflumuron [Recruit® II bait] or noviflumuron [Recruit® III bait]), FirstLine® Termite Defense System (sulfluramid), Exterra® Termite Interception and Baiting System (diflubenzuron [Labyrinth® bait]), Subterfuge® Termite Bait (hydramethylnon), and Outpost® Termite Bait Response (diflubenzuron). Not all of these bait systems are equally effective. It is advisable to review the independent research that has been conducted on a particular bait, as some products have been evaluated much more rigorously than others.

Spectracide Terminate® (sulfluramid) and Termirid® 613 (borate) can be purchased by homeowners. However, Terminate® is not recommended as sole protection against termites, and an active infestation should be treated by a professional. Termirid® can be used to reduce subterranean termite populations. Little or no research has been conducted to verify the effectiveness of these products, particularly when used by homeowners.

When deciding whether or not to use baits, it is important to remember that this is a relatively new technology. Baits are still being evaluated and their long-term success is unproven. However, the concept of controlling termites with baits is promising. You, the termite control professional, must determine which approach, colony elimination or suppression, will succeed in each situation.

Baits may require from a few weeks to several months to control termites, depending on such factors as the product selected, application timing, the time to discovery by the termites, the amount of feeding the colony does, colony size and other control measures used.

Baits fit well in an integrated pest management (IPM) control program, along with eliminating conditions conducive to termite infestation, judicious use of liquid soil products as a spot or limited barrier application and use of wood treatment products. An IPM program will require more frequent visits to the site for monitoring and to provide ongoing service. Applicators are strongly encouraged to familiarize themselves with bait technology and future products.

Drilling is hard work; there are days you might drill every day, it is best to work as a two-man team if you are doing termite treatments. Beware of hitting rebar and deep footers. After your first inspection, draw a detailed plan of action and map your treatment methods, this is required by law and good for your records and customers as well. Subs are easy to kill if you do a good treatment. It might take a month but if termites are treated correctly, Subs are walking dead.

Termite Product Applications

Building With a Basement and Crawl Space

Basement: For an interior vertical barrier, drill the floor slab and space holes about one foot apart. Drilling may be required along the foundation walls, along one side of partition walls, along both sides of load-bearing wall, around sewer pipes, floor drains, conduits, and any crack in the basement floor. Using a sub-slab injector, inject the insecticide at the rate of 4 gallons per 10 linear feet. For an insecticide barrier around the exterior of foundation walls, apply an insecticide by rodding and/or trenching. The rod holes should be spaced 1 to 1 1/2 feet apart to provide a continuous chemical barrier. If a trench is necessary, it should not be wider than 6 inches. Inject insecticide using rodding technique at the rate of 4 gallons per 10 linear feet. Cover the trench with untreated soil.

Crawl Spaces

Establish vertical barriers by rodding and/or trenching procedures. A shallow trench should not be wider than 6 inches. Space rod holes about 1 to 1 1/2 feet apart. Apply insecticide at the rate of 4 gallons per 10 linear feet per foot of depth. Do not treat soil in crawl space area with a broadcast insecticide spray.

Hollow Masonry Units of the Foundation Walls

Treat through masonry voids to provide a continuous chemical barrier at the top of the footing. When treatment is necessary, access holes must be drilled through mortar joints below the sill plate, as close as possible to the footing. Apply insecticide at the rate of 2 gallons per 10 linear feet. Plug all holes with mortar or any other special compound.

Bath Traps

Soil may require insecticide treatment if it is exposed beneath and around plumbing/waste pipe entrances through a concrete slab. Remove any wood or other debris and treat the soil by rodding or flooding with an insecticide solution.

Treatment Near Ponds, Wells, Cisterns, and Faulty Foundation Walls, Around Pipes or Utility Lines

Insecticide applications through rodding is discouraged in such situations. The suggested procedure is to make a trench and remove the soil to be treated onto a heavy plastic sheeting or similar material. Treat the excavated soil with insecticide at the rate of 4 gallons per 10 linear feet per foot of depth. Mix the soil with insecticide and replace it in the trench. Cover the treated soil with a thin layer of untreated soil. In the case of wells, ponds, and cisterns, if a rodding technique is necessary, the distance between the treated area and the water source should be 50 feet or more.

Wood Treatment

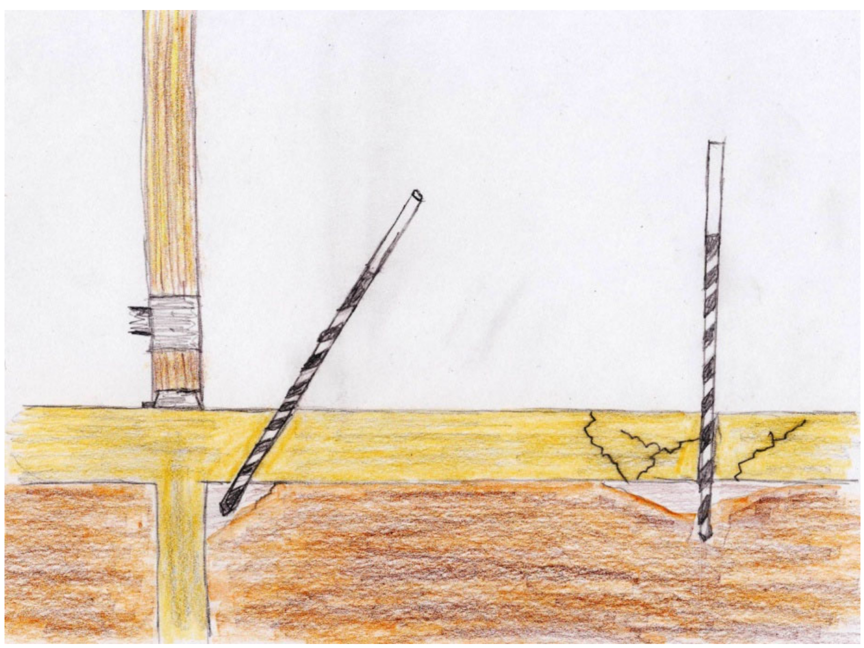
In addition to soil treatment, it may be necessary to treat infested wood with insecticide spray or injection. Applications are made to inaccessible areas by drilling and then injecting the insecticide solution. Broadcast spray must be limited to wood in attics, crawl spaces and unfinished basements or similar unoccupied areas.

Treatment of Secondary Subterranean Termite Colony

Apply insecticide to infested wood and void spaces with a crack and crevice injector.

Carefully measure and mix the product and always use your air gap water protection device. So many applicators risk damaging the public water supply if they do not follow instructions and do not utilize the air gap protection device. Most applicators do not carefully measure the product to the instructions, this a not cost effective and usually the owners or managers are the ones need to properly instruct the chemical usage. I think this chemical costs about 80 cents an ounce and that doesn't seem to be that much but if you are wasting two or three dollars per job, that will cut the profit and may indeed end someone career.

You need to properly identify the pest target, so many applicators treat subs with drywood methods and these methods will not work. Subs live under the slab. Pull the carpet up and drill down. Control of subterranean termites in buildings can be difficult and expensive. Chemical (termiticide) treatment is a proven means of protecting buildings from further damage by subterranean termites. The majority of treatments involves injection of a termiticide around the entire perimeter of the foundation and under the slab (called a full treatment) or may only require a partial treatment of the perimeter if the infestation is very localized. Some termiticides can be sprayed if the infestations are suited to this type of treatment. Therefore, as previously mentioned, it is important that a correct diagnosis and thorough inspection be made before any control measures are implemented.



You must drill pass the concrete slab into order to reach the termites.

Drilling and dusting the wall voids will help control subs. Always follow the State rule and the manufacturer's label instructions. Some of my suggestions may not be allowed with certain chemicals and in certain States with California being the strictest. There are several products that I can think of that will destroy subs but few manufacturers will list it on the label. When in doubt, follow the label. This type of treatment will also kill bed bugs and cockroaches. Below, is an example of trenching and drenching or some will say "rodding". This professional is wearing proper respiratory protection but needs gloves while pumping 4 gallons of chemical for every ten feet of trench to kill subs.

Termite Prevention Sub-Section

Preventive practices are a critical aspect of termite control management. Prevention of subterranean termite infestation of wooden structures centers upon disrupting their ability to locate moisture, food (wood), and shelter. Avoid moisture accumulation near the foundation, which provides water needed for termite survival. Divert water away from the foundation with properly functioning downspouts, gutters, and splash blocks. Soil needs to be graded or sloped away from the foundation in order for surface water to drain away from the building.

Cellulose
Cellulose (wood, mulch, paper, etc.) that is in contact with soil provides termites with ready and unobservable access to food. It is very important to eliminate any contact between the wooden parts of the house foundation and the soil. Maintain at least 6 inches between the soil and porch steps, lattice work, door or window frames, etc. Never stack or store firewood, lumber, newspapers, or other wood products against the foundation or within the crawl space. Prevent trellises, vines, etc. from touching the house. Before and during construction, never bury wood scraps or waste lumber in the backfill, especially near the building. Be sure to remove wooden or cellotex form boards, grade stakes, etc. used during construction. Remove old tree stumps and roots around and beneath the building. Avoid or minimize use of wood mulch next to the foundation.

Soil Barrier Termiticides
Conventional soil treatments rely on creating a chemical barrier in the soil that is toxic to termites when they come into contact with it. Many also have repellent characteristics which causes the termites to avoid treated soil. To achieve termite control for long periods of time, such termiticides must be applied as a continuous barrier in the soil next to and under the foundation. If there are untreated gaps in the soil, termites may circumvent the chemical treatment. Hence, such treatments during preconstruction can provide for more uniform coverage. Once a home is constructed, the chemical has to be injected through drill holes and trenching around the foundation, which can result in less accurate coverage. Effective termite control usually requires specialized equipment and often 150 or more gallons of prepared termiticide solution per house, depending on size, basement, etc.

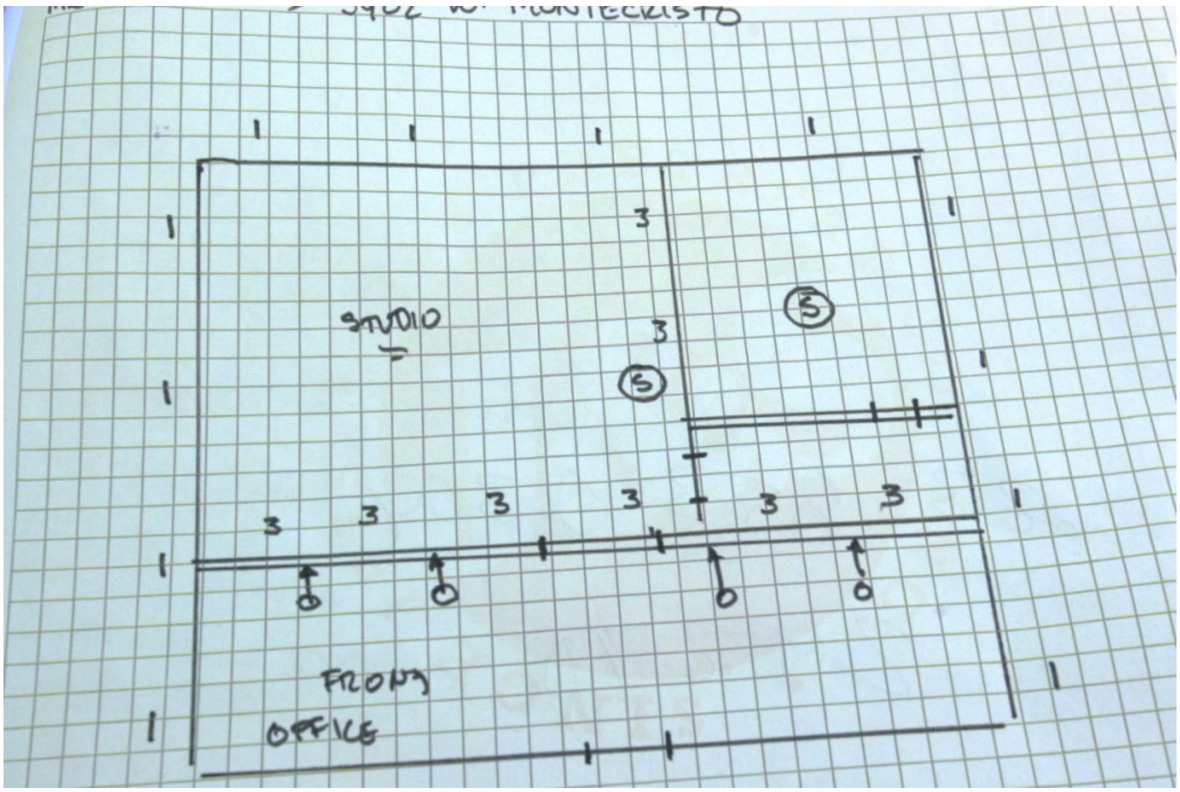
Termiticides that act by creating a chemical barrier in the soil include bifenthrin (Talstar®), cypermethrin (Demon®, Prevail®), and permethrin (Dragnet®, Prelude®). Chlorpyrifos (Dursban®) can be used only during preconstruction and only until December 31, 2005.

In reference to "**spot treatments only**" (using chemical barrier termiticides only in areas of the house where termites are seen), most pest management firms will refuse such treatments or will not guarantee them. The reason is that termites have a very high probability of finding other untreated points of entry into the structure.

Localized spot treatments are considered risky except in re-treatment situations.

Treated-Zone - Termiticides
The most recent termiticides to be marketed are non-repellent to termites, but show delayed toxicity as termites forage through treated soil, which they do not avoid. As termites penetrate the "treated zone," they contact the active ingredient, which causes delayed mortality and also possibly allows the termites to be overcome by lethal microbes.

Furthermore, the toxicant is thought to be passed to nest mates through grooming activities and social food exchange (trophallaxis). Control usually is achieved within 3 months. As with soil barrier termiticides, specialized application equipment and large volumes of chemical solution are needed. Non-repellent termiticides include fipronil (Termidor®), imidacloprid (Premise®), and chlorfenapyr (Phantom®).



TERMITE TREATMENT ZONE RECORD

There are several methods of patching the drill holes. Many applicators prefer the caulking type of patch but others like to mix cement and do it the old-school way. Either way, termite treatment is a hard way to make money. It is good money but long and hard work. The good news, there are more termites and they seem to be thriving.

Every day I am able to find subs and drywoods attacking both homes and businesses. I think it is best to purchase two of the best hammer drill and bits you can afford. It is no fun to run in to a well-poured slab or rebar. I prefer the 4-inch thick slabs but they are rare.

Required Inspection
By state law, the minimum requirement for termite inspections includes visual searches of accessible areas. However, detection of difficult-to-find infestations may require removing walls, paneling, and stucco, as well as using ladders and scaffolds.

Read the pesticide product label - The label tells you exactly how the product is to be used and provides information on potential risks. If the label does not include directions to control termites and protect the structure, then the product is not intended to protect the structure against termites and should not be applied. If you wish to see a copy of the product label, ask the company representative for a copy. Always be prepared to provide a copy of the label information to the business or homeowner. We cannot stress the dangers of pesticide application and the high death and injury rate due to applicators not following label instructions.

Be aware of the how soon you can return to the treated residence - The time required before the residence can be re-occupied will vary by product and will be indicated on product labels. Make sure to inform the business or homeowner when it is safe to reenter the building.

Whatever termite treatment, always write down everything you did, take photographs and file properly label these to protect yourself. Even if you did a perfect job!

Carefully write the chemical amounts and document the areas you did not treat.

Both the State and the customers like to see this professionalism. Of course, paperwork takes a large percentage of time, but it is an insurance policy and covers your rear end if something comes back.

There are lawyers that specialize in freedom of information laws and will inspect State files and customer's complains in order to find a lawsuit. These lawyers look for ways to sue pesticide applicators, primarily the owners of the company and the pesticide manufacturer.

One area that needs attention...you as a professional (PCA) need to develop a relationship with the State Agency in order to call and make important concerns known to the State before these concerns come back on you.

Alternative Termite Controls

Treated Wood

Borates (disodium octaborate tetrahydrate [Tim-bor®, Bora-Care®, Jecta®], Impel®) and pressure-treatments (creosote, chromated copper arsenate [CCA]) protect wood against termites and wood-decay fungi. However, even creosote-treated railroad ties and telephone poles, and CCA-treated wood, over time, can be subject to termite attack. Termites can build mud tubes over treated surfaces. Furthermore, they can gain entry through cut and cracked ends or areas where the chemical has not sufficiently penetrated.

Wood treatments are primarily used to supplement other termite control measures, because termites are able to attack untreated wood in other areas of the structure. It is advisable to use pressure-treated wood in situations where wood is in direct contact with soil or is exposed to rainfall. Borates are fairly soluble in water, so borate-treated wood should be protected from constant rewetting.

Borates may be applied to wood by homeowners. As of 1 January 2004, CCA-treated wood is no longer available for use in most residential settings because of concerns regarding its arsenic content.

Physical Barriers

Physical barriers are particularly appropriate during the preconstruction phase to provide protection of the structure from subterranean termites. One such physical barrier is stainless-steel wire mesh (TermiMesh®) that is fitted around pipes, posts, or foundations. The newest physical barrier, Impasse® Termite System, contains a liquid termiticide (lambda-cyhalothrin) locked between two layers of heavy plastic that is installed before the concrete slab is poured. It is supplemented with Impasse® Termite Blocker, which uses special fittings around plumbing and electrical pipes and conduits.

Biological Control Agents

Certain species of parasitic round worms (nematodes) will infest and kill termites and other soil insects. They have been promoted and marketed by a few companies. Although effective in the laboratory, control is often quite variable under field conditions. Limited success with nematode treatments may be attributed to the ability of termites to recognize and wall-off infected individuals, hence limiting the spread of nematodes throughout the colony.

Furthermore, soil moisture and soil type appear to limit the nematode's ability to move in the soil and locate termites. A fungus Metarhizium anisopliae (Bio-Blast®) is a biological termiticide that requires special application and handling techniques. It is labeled for aboveground application to termite infestations in structures, but it is not labeled for application to the soil.

Spray effectiveness is enhanced when applied to many foraging termites because infected termites can pass the fungus to nest mates. However, it is difficult to infect a large enough number of termites for the infection to spread throughout the colony. Furthermore, it provides no long-lasting residual activity, and the fungal spores die with the dead termites.

Insufficient research has been conducted to indicate whether this is an effective method for controlling termites.

Elimination of Dursban Pesticide for Nearly all Household Uses

To protect children and public health, the EPA and the manufacturer of the pesticide Dursban have agreed to eliminate its use for nearly all household purposes and to move to significantly reduce residues of it on several foods regularly eaten by children.

Dursban, also known as chlorpyrifos, is the most widely used household pesticide produced in the U.S. It is an ingredient used for a broad range of lawn and home insecticide products, for agricultural purposes, and for termite treatment.

Under the agreement, production will cease and there will be a phase-out of all home, lawn and garden uses, as well as the vast termite control uses.

"Chlorpyrifos is part of a class of older, riskier pesticides, some going back 50 years. Exposure to these kinds of pesticides can cause neurological effects. Now that we have completed the most extensive evaluation ever conducted on the potential health hazards from a pesticide, it is clear that the time has come to take action to protect our children from exposure to this chemical," said EPA Administrator Carol M. Browner.

The agreement mandates that all uses will be phased out this year in areas where children could be exposed, including schools, daycare centers, parks, recreation areas, hospitals, nursing homes, stores and malls. In addition, the agreement calls for canceling or significantly lowering allowable residues for several foods regularly eaten by children, such as tomatoes, apples and grapes. These actions will be taken by the beginning of the next growing season.

Wood Preservative Sub-Section

Many of our students are not pesticide applicators but are in some type of wood preservation or similar work, like building wine vats or wood working. Because States may require these professionals to possess a pesticide license, we will examine wood preservatives in relationship to wood destroyers and wood preservation methods. Wood preservatives must meet two broad criteria: (1) They must provide the desired wood protection in the intended end use, and (2) they must do so without presenting unreasonable risks to people or the environment. Because wood preservatives are considered to be a type of pesticide, the U.S. Environmental Protection Agency (EPA) is responsible for their regulation. Federal law requires that before selling or distributing a preservative in the United States, a company must obtain registration from EPA. Before registering a new pesticide or new use for a registered preservative, EPA must first ensure that the preservative can be used with a reasonable certainty of no harm to human health and without posing unreasonable risks to the environment. To make such determinations, EPA requires more than 100 different scientific studies and tests from applicants. This area discusses only wood preservatives registered by the EPA.

Some preservatives are classified as “restricted use” by the EPA and these can be used only in certain applications and can be applied only by certified pesticide applicators. Restricted use refers to the chemical preservative and not to the treated wood product. The general consumer may buy and use wood products treated with restricted-use pesticides; EPA does not consider treated wood a toxic substance nor is it regulated as a pesticide. Although treated wood is not regulated as pesticide, there are limitations on how some types of treated wood should be used. Consumer Information Sheets (EPA-approved) are available from retailers of creosote-, pentachlorophenol-, and inorganic-arsenical-treated wood products.

The sheets provide information about the preservative and the use and disposal of treated-wood products (see Synopsis of EPA-Approved Consumer Information Sheets for Wood Treated with CCA, ACZA, Creosote, or Pentachlorophenol). The commercial wood treater is bound by the EPA regulation and can treat wood only for an end use that is allowed for that preservative.

Some preservatives that are not classified as restricted by EPA are available to the general consumer for non-pressure treatments. It is the responsibility of the end user to apply these preservatives in a manner that is consistent with the EPA-approved labeling. Registration of preservatives is under constant review by the EPA, and a responsible State or Federal agency should be consulted as to the current status of any preservative.

Penta or Pentachlorophenol

Penta or Pentachlorophenol (PCP) is an organochlorine compound used as a pesticide and a disinfectant. First produced in the 1930s, it is marketed under many trade names. It can be found in two forms: PCP itself or as the sodium salt of PCP, which dissolves easily in water.

In the past, PCP has been used as a herbicide, insecticide, fungicide, algaecide, disinfectant and as an ingredient in antifouling paint. Some applications were in agricultural seeds (for nonfood uses), leather, masonry, wood preservation, cooling tower water, rope and paper mill system. Its use has been significantly declined due to the high toxicity of PCP and its slow biodegradation.

There are two general methods for preserving wood. The pressure process method involves placing wood in a pressure-treating vessel where it is immersed in PCP and then subjected to applied pressure. In the non-pressure process method, PCP is applied by spraying, brushing, dipping, and soaking. Utility companies save millions of dollars in replacement poles, because the life of these poles increases from approximately 7 years for an untreated pole to about 35 years for a preservative-treated pole.

PCP has been detected in surface waters and sediments, rainwater, drinking water, aquatic organisms, soil, and food, as well as in human milk, adipose tissue, and urine. As PCP is generally used for its properties as a biocidal agent, there is considerable concern about adverse ecosystem effects in areas of PCP contamination.

Releases to the environment are decreasing as a result of declining consumption and changing use methods. However, PCP is still released to surface waters from the atmosphere by wet deposition, from soil by run off and leaching, and from manufacturing and processing facilities.

PCP is released directly into the atmosphere via volatilization from treated wood products and during production.

Finally, releases to the soil can be by leaching from treated wood products, atmospheric deposition in precipitation (such as rain and snow), spills at industrial facilities and at hazardous waste sites.

Since the early 1980s, the purchase and use of PCP in the U.S has not been available to the general public. Nowadays most of the PCP used in the U.S is restricted to the treatment of utility poles and railroad ties. In the United States, any drinking water supply with a PCP concentration exceeding the MCL, 1 ppb, must be notified by the water supplier to the public.

Disposal of PCP and PCP contaminated substances are regulated under RCRA as a F-listed hazardous waste.

What are the key points for parents and consumers concerned about exposure from structures made of CCA-treated wood?

- ✓ If you are concerned about potential exposure to arsenic, sealants, when applied at least once a year, have been shown to reduce dislodgeable arsenic from the wood.
- ✓ Oil or water-based, penetrating sealants or stains are preferred.
- ✓ As always, parents and other caretakers should follow these precautions for children who play on or near decks. Always wash hands thoroughly after contact with treated wood, especially prior to eating and drinking, and ensure that food does not come into direct contact with any treated wood.
- ✓ At this time, we do not believe there is any reason to remove or replace CCA treated structures, including decks and playground equipment, but all the things and laws change like on an everyday basis.
- ✓ Consumers should follow manufacturer recommendations when handling the wood, including the same precautions that workers should take: wear gloves when handling wood, wear goggles and dust masks when sawing and sanding, always wash hands before eating, and never burn CCA treated wood.

Precautions and Personal Protection Measures

Wood treated with modern preservatives is generally safe to handle given appropriate handling precautions and personal protection measures. However, treated wood may present certain hazards in some circumstances such as during combustion or where loose wood dust particles or other fine toxic residues are generated or where treated wood comes into direct contact with food and agriculture.

Preservatives containing copper in the form of very small particles have recently been introduced to the market, usually with "micronized" or "micro" trade names and designations such as MCQ or MCA. While the manufacturers represent that these products are safe and EPA has registered these products, some groups have expressed concerns regarding exposure to engineered sub-micron and nano-sized copper particles. These concerns have led to a debate among advocacy groups and governments on whether special regulation of nanotechnology is warranted.

Material safety data sheets and safe handling guidelines are required by law to be provided by suppliers of wood preservative chemicals and treated wood products. This information should be obtained and reviewed before handling and using wood preservative chemicals and treated wood products

Re-Registration Eligibility Decisions (RED)
EPA has completed its re-registration eligibility decisions (RED) for the heavy duty wood preservatives chromated arsenicals, pentachlorophenol, and creosote. In general, EPA has determined that the compounds contribute benefits to society and are eligible for reregistration provided the mitigation measures and associated label changes identified in the REDs are implemented and required data are submitted. In its risk assessments, the Agency identified risks of concern associated with occupational exposure (i.e., treatment plant workers) to all three preservatives and ecological exposure to pentachlorophenol and creosote.

Chromated Copper Arsenate (CCA)

Chromated copper arsenate (CCA) is a chemical wood preservative containing chromium, copper and arsenic. CCA is used in pressure treated wood to protect wood from rotting due to insects and microbial agents. EPA has classified CCA as a restricted use product, for use only by certified pesticide applicators.

CCA has been used to pressure treat lumber since the 1940s. Since the 1970s, the majority of the wood used in outdoor residential settings has been CCA-treated wood. Pressure treated wood containing CCA is no longer being produced for use in most residential settings, including decks and playsets.

The Agency has completed its reregistration eligibility decision (RED) and will continue to work with stakeholders to implement its decision. Pesticide manufacturers to voluntarily phased out certain CCA use for wood products around the home and in children's play areas. Effective December 31, 2003, no wood treater or manufacturer may treat wood with CCA for residential uses, with certain exceptions.

Timeline for Reregistration/Risk Assessment
September 25, 2008 – Chromated Arsenicals Reregistration Eligibility Decision (RED) signed.
November 19, 2008 – Announce availability of RED in Federal Register.
March 31, 2009 – Updated product labels reflecting mitigation to be submitted to EPA.
December 31, 2013 – All treatment plants to be upgraded to reflect measures outlined in RED.
Synopsis of EPA-approved consumer information sheets for wood treated with CCA, ACZA, creosote, or pentachlorophenol

NOTE: This is only a synopsis of information contained in consumer information sheets. For complete consumer information sheets, contact your treated wood supplier or the website of the Environmental Protection Agency.

Handling Precautions

- Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing, sanding, and machining treated wood, wear a dust mask. Whenever possible, these operations should be performed outdoors to avoid indoor accumulations of airborne sawdust from treated wood. When power-sawing and machining, wear goggles to protect eyes from flying particles. Wear gloves when working with the wood. After working with the wood, and before eating, drinking, toileting, and use of tobacco products, wash exposed areas thoroughly. Avoid frequent or prolonged skin contact with creosote- or pentachlorophenol-treated wood. When handling creosote- or pentachlorophenol-treated wood, wear long-sleeved shirts and long pants and use gloves impervious to the chemicals (for example, gloves that are vinyl coated). Because preservatives or sawdust may accumulate on clothes, they should be laundered before reuse. Wash work clothes separately from other household clothing.
- Treated wood should not be burned in open fires or in stoves, fireplaces, or residential boilers, because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (such as construction sites) may be burned only in commercial or industrial incinerators or boilers in accordance with state and Federal regulations. CCA-treated wood can be disposed of with regular municipal trash (municipal solid waste, not yard waste) in many areas. However, state or local laws may be stricter than federal requirements. For more information, please contact the waste management agency for your state.

- Use Site Precautions.
- All sawdust and construction debris should be cleaned up and disposed of after construction. Do not use treated wood under circumstances where the preservative may become a component of food or animal feed. Examples of such sites would be use of mulch from recycled arsenic-treated wood, cutting boards, counter tops, animal bedding, and structures or containers for storing animal feed or human food. Only treated wood that is visibly clean and free of surface residue should be used for patios, decks, and walkways. Do not use treated wood for construction of those portions of beehives which may come into contact with honey. Treated wood should not be used where it may come into direct or indirect contact with drinking water, except for uses involving incidental contact such as docks and bridges.

- Logs treated with pentachlorophenol should not be used for log homes. Wood treated with creosote or pentachlorophenol should not be used where it will be in frequent or prolonged contact with bare skin (for example, chairs and other outdoor furniture), unless an effective sealer has been applied. Creosote- and pentachlorophenol-treated wood should not be used in residential, industrial, or commercial interiors except for laminated beams or building components that are in ground contact and are subject to decay or insect infestation and where two coats of an appropriate sealer are applied. Do not use creosote- or pentachlorophenol-treated wood for farrowing or brooding facilities.
- Wood treated with pentachlorophenol or creosote should not be used in the interiors of farm buildings where there may be direct contact with domestic animals or livestock that may crib (bite) or lick the wood. In interiors of farm buildings where domestic animals or livestock are unlikely to crib (bite) or lick the wood, creosote- or pentachlorophenol-treated wood may be used for building components that are in ground contact and are subject to decay or insect infestation and where two coats of an appropriate sealer are applied. Sealers may be applied at the installation site. Urethane, shellac, latex epoxy enamel, and varnish are acceptable sealers for pentachlorophenol-treated wood. Coal-tar pitch and coal-tar pitch emulsion are effective sealers for creosote-treated wood-block flooring. Urethane, epoxy, and shellac are acceptable sealers for all creosote-treated wood.

This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

Wood Preservative Chemical Classes

Before a wood preservative can be approved for pressure treatment of structural members, it must be evaluated to ensure that it provides the necessary durability and that it does not greatly reduce the strength properties of the wood. The EPA typically does not evaluate how well a wood preservative protects the wood. Traditionally this evaluation has been conducted through the standardization process of the AWPA. The AWPA Book of Standards lists a series of laboratory and field exposure tests that must be conducted when evaluating new wood preservatives. The durability of test products are compared with those of established durable products and nondurable controls. The results of those tests are then presented to the appropriate AWPA subcommittees for review. AWPA subcommittees are composed of representatives from industry, academia, and government agencies who have familiarity with conducting and interpreting durability evaluations. Preservative standardization by AWPA is a two-step process. If the performance of a new preservative is considered appropriate, it is first listed as a potential preservative. Secondary committee action is needed to have the new preservative listed for specific commodities and to set the required treatment level.

Two General Classes
Wood preservatives have traditionally been divided into two general classes: (1) Oil-type or oil-borne preservatives, such as creosote and petroleum solutions of pentachlorophenol, and (2) waterborne preservatives that are applied as water solutions or with water as the carrier. Many different chemicals are in each of these classes, and each has different effectiveness in various exposure conditions. Some preservatives can be formulated so that they can be delivered with either water or oil-type carriers. In this chapter, both oil-borne and waterborne preservative chemicals are described as to their potential end uses.

Chemical preservatives can be classified into three broad categories: water-borne preservatives, oil-borne preservatives, and light organic solvent preservatives (LOSPs). These are discussed in more detail below.

Timber or lumber that is treated with a preservative generally have it applied through vacuum and/or pressure treatment. The preservatives used to pressure-treat timber are classified as pesticides. Treating timber provides long-term resistance to organisms that cause deterioration. If it is applied correctly, it extends the productive life of timber by five to ten times. If left untreated, wood that is exposed to moisture or soil for sustained periods of time will become weakened by various types of fungi, bacteria or insects.

Waterborne Preservatives
Waterborne preservatives are often used when cleanliness and paintability of the treated wood are required. Formulations intended for use outdoors have shown high resistance to leaching and very good performance in service.

Waterborne preservatives are included in specifications for items such as lumber, timber, posts, building foundations, poles, and piling. Because water is added to the wood in the treatment process, some drying and shrinkage will occur after installation unless the wood is kiln-dried after treatment.

Copper is the primary biocide in many wood preservative formulations used in ground contact because of its excellent fungicidal properties and low mammalian toxicity. Because some types of fungi are copper tolerant, preservative formulations often include a co-biocide to provide further protection.

Inorganic arsenicals are a restricted-use pesticide. For use and handling precautions of pressure-treated wood containing inorganic arsenicals, refer to the EPA-approved Consumer Information Sheets.

Water is the most common solvent carrier in preservative formulations due to its availability and low cost. Water-borne systems do however have the drawback that they swell timber, leading to increased twisting, splitting and checking than alternatives.

Acid Copper Chromate (ACC)
Acid copper chromate (ACC) contains 31.8% copper oxide and 68.2% chromium trioxide (AWPA P5). The solid, paste, liquid concentrate, or treating solution can be made of copper sulfate, potassium dichromate, or sodium dichromate. Tests on stakes and posts exposed to decay and termite attack indicate that wood well impregnated with ACC generally provides acceptable service. However, some specimens placed in ground contact have shown vulnerability to attack by copper-tolerant fungi. ACC has often been used for treatment of wood in cooling towers. Its current uses are restricted to applications similar to those of chromated copper arsenate (CCA).

ACC and CCA must be used at low treating temperatures (38 to 66 °C (100 to 150 °F)) because they are unstable at higher temperatures. This restriction may involve some difficulty when higher temperatures are needed to obtain good treating results in woods such as Douglas-fir. This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

Ammoniacal Copper Zinc Arsenate (ACZA)
Ammoniacal copper zinc arsenate (ACZA) is commonly used on the West Coast of North America for the treatment of Douglas-fir. The penetration of Douglas-fir heartwood is improved with ACZA because of the chemical composition and stability of treating at elevated temperatures. Wood treated with ACZA performs and has characteristics similar to those of wood treated with CCA.

ACZA should contain approximately 50% copper oxide, 25% zinc oxide, and 25% arsenic pentoxide dissolved in a solution of ammonia in water (AWPA P5). The weight of ammonia is at least 1.38 times the weight of copper oxide. To aid in solution, ammonium bicarbonate is added (at least equal to 0.92 times the weight of copper oxide). ACZA replaced an earlier formulation, ammoniacal copper arsenate (ACA) that was used for many years in the United States and Canada.

Chromated Copper Arsenate (CCA)
(Most of this information will seem to repeat throughout this manual that is because the widespread use of this chemical.) Chromated copper arsenate or CCA, is a chemical preservative that protects wood from rotting due to insects and microbial agents. CCA contains arsenic, chromium and copper. CCA has been used to pressure treat lumber used for decks, playgrounds (playsets) and other outdoor uses since the 1930’s. Since the 1970’s, the majority of the wood used in residential settings was CCA-treated wood.

CCA is a registered chemical pesticide that is subject to U.S. Environmental Protection Agency's (EPA's) regulation under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The playground equipment made with wood treated with CCA is the jurisdictional responsibility of the CPSC and would be subject to the rules of the CPSC's Federal Hazardous Substances Act if found to be a hazardous substance.

Chromated copper arsenate (CCA) is a wood preservative used for timber treatment since the mid-1930s. It is a mix of copper, chromium, and arsenic formulated as oxides or salts. It preserves the wood from decay fungi, wood attacking insects, including termites, and marine borers. It also improves the weather-resistance of treated timber and may assist paint adherence in the long term.

Tanalith" "SupaTimber" and "Celcure"

CCA is known by many trade names, including the worldwide brands "Tanalith" "SupaTimber" and "Celcure". The chromium acts as a chemical fixing agent and has little or no preserving properties; it helps the other chemicals to fix in the timber, binding them through chemical complexes to the wood's cellulose and lignin. The copper acts primarily to protect the wood against decay fungi and bacteria, while the arsenic is the main insecticidal component of CCA. CCA is widely used around the world as a heavy duty preservative, often as an alternative to creosote, and pentachlorophenol. Other water-borne preservatives like CCA include alkaline copper quaternary compounds (ACQ), copper azole (CuAz), ammoniacal copper zinc arsenate (ACZA), copper citrate, and copper HDO (CuHDO)

Recognized for the greenish tint it imparts to timber, CCA is a preservative that has been extremely common for many decades. Over time small amounts of the CCA chemicals, mainly the arsenic, may leach out of the treated timber. This is particularly the case in acidic environments. The chemicals may leach from the wood into surrounding soil, resulting in concentrations higher than naturally occurring background levels. A study found that 12–13 percent of the CCA leached from treated wood buried in compost during a 12-month period.

On the other hand, there have been many other studies in less aggressive soil types that show leaching to be as low as 0.5 ppm (red pine poles in service,) or up to 14 ppm (treated pine in garden beds). Soil contamination due to the presence of CCA-treated wood after 45 years is minimal. Should any chemicals leach from the wood they are likely to bind to soil particles, especially in soils with clay or soils that are more alkaline than neutral.

A number of countries have reviewed CCA during recent years and have looked at limiting the public exposure to CCA-treated timber by restricting its application in residential situations. These reviews have resulted from increasing public pressures and perceptions that arsenic-containing timber poses a health hazard. In response to these pressures the preservation industry in the USA and Canada volunteered not to use CCA for the treatment of residential timber, and on 1 January 2004 the United States Environmental Protection Agency (EPA) began restricting the use of CCA for such purposes.

Exceptions were allowed, including the treatment of shakes and shingles, permanent wood foundations, and certain commercial applications. It should be emphasized however that the regulatory agencies advised that CCA-treated timber products already in use pose no significant threat to health. Indeed, CCA will continue to be used in North America in a wide variety of commercial and industrial applications such as poles, piling, retaining structures and many others.

CCA timber is still in widespread use in many countries and remains an economical option for conferring durability to perishable timbers such as plantation grown pine. Although widespread restrictions followed the publication of studies which showed low-level leaching from in-situ timbers (such as children's playground equipment) into surrounding soil, a more serious risk is presented if CCA-treated timber is burnt in confined spaces such as a domestic fire or barbecue. Scrap CCA construction timber continues to be widely burnt through ignorance, in both commercial and domestic fires.

Notwithstanding this, disposal by burning i.e. in approved incinerators is an acceptable option. It is particularly attractive if there is some energy captured in the process. In addition, CCA treated timber wastes can also be effectively incinerated using high temperatures, i.e. 800°-1100°C.

Disposal of large quantities of CCA-treated wastes or spent timber at the end of its lifecycle has been traditionally through controlled landfill sites. Such sites are lined to make them impervious in order to prevent losses to the water table and they are covered to prevent rainfall washing out any contained potential toxicants. These controlled sites handle a range of waste materials potentially more noxious than that posed by CCA-treated timber, e.g. paint-stuffs, car batteries, etc. Today, landfill sites are becoming scarcer and disposal of waste materials is becoming economically unattractive. The wood preservation and timber industries are therefore researching better ways of dealing with waste treated timber, including CCA-treated material.

In CCA treatment, copper is the primary fungicide, arsenic is a secondary fungicide and an insecticide, and chromium is a fixative which also provides ultraviolet (UV) light resistance. Recognized for the greenish tint it imparts to timber, CCA is a preservative that was extremely common for many decades.

Once decay has started in a piece of wood, the rate and extent of deterioration depend on the duration of favorable conditions for fungal growth. Decay will stop when the temperature of the wood is either too low or too high or when the moisture content is lower than the fungi's requirements. Decay can resume when the temperature and moisture content become favorable again. Early decay is more easily noted on freshly exposed surfaces of unseasoned wood than on wood that has been exposed and discolored by the weather.

Pressure Treatment Process

Because many of our students are not termite applicators but are in the wood or agriculture pest industry, we will cover the wood pressure treatment process. In the pressure treatment process, an aqueous solution of CCA is applied using a vacuum and pressure cycle, and the treated wood is then stacked to dry. During the process, the mixture of oxides reacts to form insoluble compounds, helping with leaching problems.

The process can apply varying amounts of preservative at varying levels of pressure to protect the wood against increasing levels of attack. Increasing protection can be applied (in increasing order of attack and treatment) for: exposure to the atmosphere, implantation within soil, or insertion into a marine environment.

In the last decade concerns were raised that the chemicals may leach from the wood into surrounding soil, resulting in concentrations higher than naturally occurring background levels. A study cited in Forest Products Journal found 12–13% of the chromated copper arsenate leached from treated wood buried in compost during a 12-month period. Once these chemicals have leached from the wood, they are likely to bind to soil particles, especially in soils with clay or soils that are more alkaline than neutral. In the United States the powerful US Consumer Product Safety Commission issued a report in 2002 stating that exposure to arsenic from direct human contact with CCA treated wood may be higher than was previously thought. On 1 January 2004, the Environmental Protection Agency (EPA) in a voluntary agreement with industry began restricting the use of CCA in treated timber in residential and commercial construction, with the exception of shakes and shingles, permanent wood foundations, and certain commercial applications. This was in an effort to reduce the use of arsenic and improve environmental safety, although the EPA were careful to point out that they had not concluded that CCA treated wood structures in service posed an unacceptable risk to the community. The EPA did not call for the removal or dismantling of existing CCA treated wood structures.

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Alkaline Copper Quaternary

Alkaline copper quaternary (ACQ) is a preservative made of copper, a fungicide, and a quaternary ammonium compound (quat), an insecticide which also augments the fungicidal treatment is a wood preservative that has come into wide use in the USA, Europe, Japan and Australia following restrictions on CCA. Its use is governed by national and international standards, which determine the volume of preservative uptake required for a specific timber end use.

Since it contains high levels of copper, ACQ-treated timber is five times more corrosive to common steel. It is necessary to use double-galvanized or stainless steel fasteners in ACQ timber.

Use of fasteners meeting or exceeding requirements for ASTM A 153 Class D meet the added requirements for fastener durability. The U.S. began mandating the use of non-arsenic containing wood preservatives for virtually all residential use timber in 2004.

The American Wood Protection Association (AWPA) standards for ACQ require a retention of 0.15 lb/ft^3 (PCF) for above ground use and 0.40 lb/ft^3 for ground contact.

Chemical Specialties, Inc. (CSI, now Viance) received U.S. Environmental Protection Agency's Presidential Green Chemistry Challenge Award in 2002 for commercial introduction of ACQ. Its widespread use has eliminated major quantities of arsenic and chromium previously contained in CCA.

Alkaline Copper Quat (ACQ)
Alkaline copper quat (ACQ) has an actives composition of 67% copper oxide and 33% quaternary ammonium compound (quat). Multiple variations of ACQ have been standardized. ACQ type B (ACQ–B) is an ammoniacal copper formulation, ACQ type D (ACQ–D) is an amine copper formulation, and ACQ type C (ACQ–C) is a combined ammoniacal-amine formulation with a slightly different quat compound. The multiple formulations of ACQ allow some flexibility in achieving compatibility with a specific wood species and application. When ammonia is used as the carrier, ACQ has improved ability to penetrate difficult-to-treat wood species. However, if the wood species is readily treatable, such as Southern Pine sapwood, an amine carrier can be used to provide a more uniform surface appearance. Recently ACQ has been formulated using small particles of copper rather than copper solubilized in ethanolamine. These formulations are discussed in more detail in the Preservatives with ICC–ES Evaluation Reports section. Use of particulate copper formulations of ACQ is currently limited to permeable woods (such as species of pine with a high proportion of sapwood), but efforts continue to adapt the treatment to a broader range of wood species.

Alkaline Copper DCOI (ACD)
Alkaline copper DCOI (ACD) is a recently proposed formulation of alkaline copper ethanolamine that utilizes 4,5-dichloro-2-N-octyl-4-isothiazolin-3-one (DCOI) as co-biocide to provide protection against copper-tolerant fungi. The ratio of alkaline copper to DCOI in the formulation ranges from 20:1 to 25:1. The ACD formulation is listed as a preservative in AWPA standards. It has been proposed for both above-ground and ground-contact applications, but at the time this chapter was finalized it had not yet been standardized for treatment of any commodities.

Copper bis(dimethyldithiocarbamate) (CDDC)
Copper bis(dimethyldithiocarbamate) (CDDC) is a reaction product formed in wood as a result of the dual treatment of two separate treating solutions. The first treating solution contains a maximum of 5% bivalent copper–ethanolamine (2-aminoethanol), and the second treating solution contains a minimum of 2.5% sodium dimethyldithiocarbamate (AWPA P5). Although this preservative is not currently commercially available, CDDC-treated wood products are included in the AWPA Commodity Standards for uses such as residential construction.

Copper Azole
Copper azole preservative (denoted as CA-B and CA-C under American Wood Protection Association/AWPA standards) is a major copper based wood preservative that has come into wide use in Canada, the USA, Europe, Japan and Australia following restrictions on CCA. Its use is governed by national and international standards, which determine the volume of preservative uptake required for a specific timber end use.

Copper azole is similar to ACQ with the difference being that the dissolved copper preservative is augmented by an azole co-biocide instead of the quat biocide used in ACQ. The azole co-biocide yields a copper azole product that is effective at lower retentions than required for equivalent ACQ performance. It is marketed widely under the Wolmanized brand in North America and the Tanalith brand across Europe and other international markets.

The AWPA standard retention for CA-B is 0.10 lb./ft^3 for above ground applications and 0.21 lb./ft^3 for ground contact applications. Type C copper azole, denoted as CA-C, has been introduced under the Wolmanized brand. The AWPA standard retention for CA-C is 0.06 lb./ft^3 for above ground applications and 0.15 lb./ft^3 for ground contact applications.

The copper azole preservative incorporates organic triazoles such as tebuconazole or propiconazole as the co-biocide, which are also used to protect food crops. The general appearance of wood treated with copper azole preservative is similar to CCA with a green coloration.

Copper HDO (CXA)
Copper HDO (CXA) is an amine copper water-based preservative that has been used in Europe and was recently standardized in the United States. The active ingredients are copper oxide, boric acid, and copper–HDO (bis-(N-cyclohexyldiazeniumdioxy copper). The appearance and handling characteristics of wood treated with copper HDO are similar to those of the other amine copper-based treatments. It is also referred to as copper xyligen. Currently, copper HDO is standardized only for applications that are not in direct contact with soil or water.

Copper Naphthenate (Waterborne)
Waterborne copper naphthenate (CuN–W) has an actives composition similar to oil-borne copper naphthenate, but the actives are carried in a solution of ethanolamine and water instead of petroleum solvent. Wood treated with the waterborne formulation has a drier surface and less odor than the oil-borne formulation. The waterborne formulation has been standardized for above-ground and some ground-contact applications.

Other Copper Compounds
These include, copper chromate, copper citrate, acid copper chromate, and ammoniacal copper zinc arsenate (ACZA). The CuHDO treatment is an alternative to CCA, ACQ and CA used in Europe and in approval stages for United States and Canada. ACZA is generally used for marine applications.

Micronized Copper Technology
Particulate (micronized or dispersed) copper preservative technology has recently been introduced in the USA and Europe. In these systems, the copper is ground to micro sized particles and suspended in water rather than being dissolved in a chemical reaction as is the case with other copper products such as ACQ and Copper Azole. There are currently two particulate copper systems in production.

One system uses a quat biocide system (known as MCQ) and is a take-off of ACQ. The other uses an azole biocide (known as MCA or CA-C) and is a take-off of copper azole.

Proponents of the particulate copper systems make the case that the particulate copper system perform as well or better than the dissolved copper systems as a wood preservative.

None of the particulate copper systems have been submitted to the American Wood Protection Association (AWPA) for evaluation, thus the particulate systems should not be used in applications Petition where AWPA standards are required.

However, all of the particulate copper systems have been tested and approved for building code requirements by the International Code Council (ICC). The particulate copper systems provide a lighter color than dissolved copper systems such as ACQ or copper azole.

Proponents of the micronized copper systems claim that the systems are subject to third party inspection under a quality monitor program. However, the monitoring program is not subject to oversight by the American Lumber Standards Committee (ALSC) as is required for the AWPA standard systems.

Two particulate copper systems, one marketed as MicroPro and the other as Wolmanized using CA-C formulation, have achieved Environmentally Preferable Product (EPP) certification. The EPP certification was issued by Scientific Certifications Systems (SCS), and is based on a comparative life-cycle impact assessment with an industry standard.

The copper particle size used in the "micronized" copper products ranges from 1 to 700 nm with an average under 300 nm. Larger particles (such as actual micron-scale particles) of copper do not adequately penetrate the wood cell walls. It is claimed by the proponents of micronized copper products that the copper nano particles which escape the wood will bond readily with organic matter and become biologically inactive.

These micronized preservatives use nano particles of copper oxide, for which there are alleged safety concerns. An environmental group has recently petitioned EPA to revoke the registration of the micronized copper products citing safety issues.

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Borate Preservatives

Boric acid, oxides and salts (borates) are effective wood preservatives and are supplied under numerous brand names throughout the world. Borate treated wood is of low toxicity to humans, and does not contain copper or other heavy metals. However, unlike most other preservatives, borate compounds do not become fixed in the wood and can readily be leached out. Therefore, borates should not be used where they will be exposed to rain, water or ground contact.

Recent interest in low toxicity timber for residential use, along with new regulations restricting some wood preservation agents, has resulted in a resurgence of the use of borate treated wood for floor beams and internal structural members.

Inorganic Boron (Borax–Boric Acid)
Borate preservatives are readily soluble in water and highly leachable and should be used only above ground where the wood is protected from wetting. When used above ground and protected from wetting, this preservative is very effective against decay, termites, beetles, and carpenter ants. Inorganic boron (SBX) is listed in AWPA standards for protected applications such as framing lumber. The solid or treating solution for borate preservatives (borates) should be greater than 98% pure, on an anhydrous basis (AWPA P5).

Acceptable borate compounds are sodium octaborate, sodium tetraborate, sodium pentaborate, and boric acid. These compounds are derived from the mineral sodium borate, which is the same material used in laundry additives.

Sodium Silicate-based Preservatives
Sodium silicate is produced by fusing sodium with sand or heating both ingredients under pressure. It has been in use since the 19th century. It can be a deterrent against insect attack and possesses minor flame-resistant properties; however, it is easily washed out of wood by moisture, forming a flake-like layer on top of the wood. One company, Timber Treatment Technology, LLC, has found that infusing timber with a chemical solution containing sodium silicate with a specified energy level applied yields wood that not only does not provide flake or layering on the wood, nor does it wash out as others have done in the past; and it provides processed timber that received a class A fire classification. Their processed wood also paints and stains as new wood does. TTT, LLC, sells these products under the name TimberSIL. Other uses include fixing pigments in paintings and cloth printing, and for preserving eggs.

EL2
EL2 is a waterborne preservative composed of the fungicide 4,5-dichloro-2-N-octyl-4-isothiazolin-3-one (DCOI), the insecticide imidacloprid, and a moisture control stabilizer (MCS). The ratio of actives is 98% DCOI and 2% imidacloprid, but the MCS is also considered to be a necessary component to ensure preservative efficacy. EL2 is currently listed in AWPA standards for above-ground applications only (Table 15–1).

KDS
KDS and KDS Type B (KDS–B) utilize copper and polymeric betaine as the primary active ingredients. The KDS formulation also contains boron, and has an actives composition of 41% copper oxide, 33% polymeric betaine, and 26% boric acid. KDS–B does not contain boron and has an actives composition of 56% copper oxide and 44% polymeric betaine. KDS is listed for treatment of commodities used above ground and for general use in contact with soil or fresh water. It is not listed for soil or fresh water contact in severe exposures.

The listing includes treatment of common pine species as well as Douglas-fir and western hemlock. KDS–B is currently in the process of obtaining listings for specific commodities. The appearance of KDS-treated wood is similar to that of wood treated with other alkaline copper formulations (light green–brown). It has some odor initially after treatment, but this odor dissipates as the wood dries.

Oligomeric Alkylphenol Polysulfide (PXTS)
PXTS is a recently developed and somewhat unusual preservative system. It is an oligomer formed by the reaction of cresylic acid and sulfur chlorides in the presence of excess sulfur. PXTS is a solid at room temperature but becomes a liquid when heated to above approximately 58 °C. It can also be dissolved and diluted in some aromatic and organic chlorinated solvents. PXTS is not currently listed for treatment of any commodities and is currently not commercially available.

Propiconazole and Tebuconazole
Propiconazole and tebuconazole are organic triazole biocides that are effective against wood decay fungi but not against insects (AWPA P5, P8). They are soluble in some organic solvents but have low solubility in water and are stable and leach resistant in wood. Propiconazole and tebuconazole are currently components of waterborne preservative treatments used for pressure-treatment of wood in the United States, Europe, and Canada. They are also used as components of formulations used to provide mold and sapstain protection. Propiconazole is also standardized for use with AWPA P9 Type C or Type F organic solvents.

Propiconazole–Tebuconazole–Imidacloprid (PTI)
PTI is a waterborne preservative solution composed of two fungicides (propiconazole and tebuconazole) and the insecticide imidacloprid. It is currently listed in AWPA standards for above-ground applications only. The efficacy of PTI is enhanced by the incorporation of a water-repellent stabilizer in the treatment solutions, and lower retentions are allowed with the stabilizer.

ESR–1721
ESR–1721 recognizes three preservative formulations. Two are the same formulations of copper azole (CA–B and CA–C) also listed in AWPA standards. The other (referred to here as ESR–1721) uses particulate copper that is ground to sub-micron dimensions and dispersed in the treatment solution. Wood treated with ESR–1721 has a lighter green color than the CA–B or CA–C formulations because the copper is not dissolved in the treatment solution. All three formulations are listed for treatment of commodities used in a range of applications, including contact with soil or freshwater. Use of ESR–1721 (dispersed copper) is currently limited to easily treated pine species.

ESR–1980
ESR–1980 includes a listing for both the AWPA standardized formulation of ACQ–D and a waterborne, micronized copper version of alkaline copper quat (referred to here as ESR–1980). The formulation is similar to ACQ in that the active ingredients are 67% copper oxide and 33% quaternary ammonium compound. However, in ESR–1980 the copper is ground to sub-micron dimensions and suspended in the treatment solution instead of being dissolved in ethanolamine. The treated wood has little green color because the copper is not dissolved in the treatment solution. The use of the particulate form of copper is currently limited to the more easily penetrated pine species, but efforts are underway to adapt the formulation for treatment of a broader range of wood species. ESR–1980 is listed for treatment of commodities used in both above-ground and ground-contact applications.

ESR–2067
ESR–2067 is an organic waterborne preservative with an actives composition of 98% tebuconazole (fungicide) and 2% imidacloprid (insecticide). The treatment does not impart any color to the wood. It is currently listed only for treatment of commodities that are not in direct contact with soil or standing water.

ESR–2240
ESR–2240 is a waterborne formulation that utilizes finely ground (micronized) copper in combination with tebuconazole in an actives ratio of 25:1. It is listed for above-ground and ground-contact applications. In addition to wood products cut from pine species, ESR–2240 can be used for treatment of hem–fir lumber and Douglas-fir plywood.

ESR–2325
ESR–2325 is another waterborne preservative that utilizes finely ground copper particles and tebuconazole as actives. The ratio of copper to tebuconazole in the treatment solution is 25:1. Its use is currently limited to more readily treated species such as the Southern Pine species group, but Douglas-fir plywood is also listed. ESR–2315 is listed for treatment of wood used above-ground and in contact with soil or fresh water.

ESR–2711
ESR–2711 combines copper solubilized in ethanolamine with the fungicide 4,5-dichloro-2-N-octyl-4-isothiazolin-3-one (DCOI). The ratio of copper (as CuO) to DCOIT ranges from 10:1 to 25:1. The ESR listing provides for both above-ground and ground-contact applications.

Oil-Borne or Oil-Type Wood Preservatives Sub-Section

Oil-type wood preservatives are some of the oldest preservatives, and their use continues in many applications. Wood does not swell from treatment with preservative oils, but it may shrink if it loses moisture during the treating process. Creosote and solutions with heavy, less volatile petroleum oils often help protect wood from weathering but may adversely influence its cleanliness, odor, color, paintability, and fire performance. Volatile oils or solvents with oil-borne preservatives, if removed after treatment, leave the wood cleaner than do the heavy oils but may not provide as much protection. Wood treated with some preservative oils can be glued satisfactorily, although special processing or cleaning may be required to remove surplus oils from surfaces before spreading the adhesive.

Coal-Tar Creosote and Creosote Solutions

Coal-tar creosote (creosote) is a black or brownish oil made by distilling coal tar that is obtained after high-temperature carbonization of coal. Advantages of creosote are (a) high toxicity to wood-destroying organisms; (b) relative insolubility in water and low volatility, which impart to it a great degree of permanence under the most varied use conditions; (c) ease of application; (d) ease with which its depth of penetration can be determined; (e) relative low cost (when purchased in wholesale quantities); and (f) lengthy record of satisfactory use. Creosote is commonly used for heavy timbers, poles, piles, and railroad ties.

AWPA Standard P1/P13 provides specifications for coal-tar creosote used for preservative treatment of piles, poles, and timber for marine, land, and freshwater use. The character of the tar used, the method of distillation, and the temperature range in which the creosote fraction is collected all influence the composition of the creosote, and the composition may vary within the requirements of standard specifications. Under normal conditions, requirements of these standards can be met without difficulty by most creosote producers.

Coal tar or petroleum oil may also be mixed with coal-tar creosote, in various proportions, to lower preservative costs. AWPA Standard P2 provides specifications for coal-tar solutions. AWPA Standard P3 stipulates that creosote–petroleum oil solution shall consist solely of specified proportions of 50% coal-tar creosote by volume (which meets AWPA standard P1/P13) and 50% petroleum oil by volume (which meets AWPA standard P4). However, because no analytical standards exist to verify the compliance of P3 solutions after they have been mixed, the consumer assumes the risk of using these solutions.

These creosote solutions have a satisfactory record of performance, particularly for railroad ties and posts where surface appearance of the treated wood is of minor importance. Compared with straight creosote, creosote solutions tend to reduce weathering and checking of the treated wood. These solutions have a greater tendency to accumulate on the surface of the treated wood (bleed) and penetrate the wood with greater difficulty because they are generally more viscous than is straight creosote. High temperatures and pressures during treatment, when they can be safely used, will often improve penetration of high-viscosity solutions.

Although coal-tar creosote or creosote solutions are well suited for general outdoor service in structural timbers, creosote has properties that are undesirable for some purposes. The color of creosote and the fact that creosote-treated wood usually cannot be painted satisfactorily make this preservative unsuitable where appearance and paintability are important.

The odor of creosote-treated wood is unpleasant to some people. Also, creosote vapors are harmful to growing plants, and foodstuffs that are sensitive to odors should not be stored where creosote odors are present. Workers sometimes object to creosote-treated wood because it soils their clothes, and creosote vapor photosensitizes exposed skin.

With precautions to avoid direct skin contact with creosote, there appears to be minimal danger to the health of workers handling or working near the treated wood. The EPA or the wood treaters should be contacted for specific information on this subject.

In 1986, creosote became a restricted-use pesticide, and its use is currently restricted to pressure-treatment facilities. For use and handling of creosote-treated wood, refer to the EPA-approved Consumer Information Sheet.

Freshly creosoted timber can be ignited and burns readily, producing a dense smoke. However, after the timber has seasoned for some months, the more volatile parts of the oil disappear from near the surface and the creosoted wood usually is little, if any, easier to ignite than untreated wood. Until this volatile oil has evaporated, ordinary precautions should be taken to prevent fires. Creosote adds fuel value, but it does not sustain ignition.

Other Creosotes
Creosotes distilled from tars other than coal tar have been used to some extent for wood preservation, although they are not included in current AWPA specifications. These include wood-tar creosote, oil-tar creosote, and water–gas-tar creosote. These creosotes provide some protection from decay and insect attack but are generally less effective than coal-tar creosote.

Pentachlorophenol Solutions
Water-repellent solutions containing chlorinated phenols, principally pentachlorophenol (penta), in solvents of the mineral spirits type, were first used in commercial dip treatments of wood by the millwork industry in about 1931. Commercial pressure treatment with pentachlorophenol in heavy petroleum oils on poles started in about 1941, and considerable quantities of various products soon were pressure treated. AWPA Standard P8 defines the properties of pentachlorophenol preservative, stating that pentachlorophenol solutions for wood preservation shall contain not less than 95% chlorinated phenols, as determined by titration of hydroxyl and calculated as pentachlorophenol.

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AWPA standard P9 defines solvents and formulations for organic preservative systems. The performance of pentachlorophenol and the properties of the treated wood are influenced by the properties of the solvent used. A commercial process using pentachlorophenol dissolved in liquid petroleum gas (LPG) was introduced in 1961, but later research showed that field performance of penta–LPG systems was inferior to penta–P9 systems.

Thus, penta–LPG systems are no longer used. The heavy petroleum solvent included in AWPA P9 Type A is preferable for maximum protection, particularly when wood treated with pentachlorophenol is used in contact with the ground. The heavy oils remain in the wood for a long time and do not usually provide a clean or paintable surface.

Because of the toxicity of pentachlorophenol, care is necessary when handling and using it to avoid excessive personal contact with the solution or vapor. Do not use indoors or where human, plant, or animal contact is likely. Pentachlorophenol became a restricted-use pesticide in November 1986 and is currently only available for use in pressure treatment. For use and handling precautions, refer to the EPA-approved Consumer Information Sheet.

The results of pole service and field tests on wood treated with 5% pentachlorophenol in a heavy petroleum oil are similar to those with coal-tar creosote. This similarity has been recognized in the preservative retention requirements of treatment specifications.

Pentachlorophenol is effective against many organisms, such as decay fungi, molds, stains, and insects. Because pentachlorophenol is ineffective against marine borers, it is not recommended for the treatment of marine piles or timbers used in coastal waters.

Copper Naphthenate

Copper naphthenate is an organometallic compound formed as a reaction product of copper salts and naphthenic acids that are usually obtained as byproducts in petroleum refining. It is a dark green liquid and imparts this color to the wood. Weathering turns the color of the treated wood to light brown after several months of exposure. The wood may vary from light brown to chocolate brown if heat is used in the treating process. AWPA P8 standard defines the properties of copper naphthenate, and AWPA P9 covers the solvents and formulations for organic preservative systems.

Copper naphthenate is effective against wood-destroying fungi and insects. It has been used commercially since the 1940s and is currently standardized for a broad range of applications. Copper naphthenate is not a restricted-use pesticide but should be handled as an industrial pesticide. It may be used for superficial treatment, such as by brushing with solutions with a copper content of 1% to 2% (approximately 10% to 20% copper naphthenate). Water-based formulations of copper naphthenate may also be available.

Oxine Copper (copper-8-quinolinolate)

Oxine copper (copper-8-quinolinolate) is an organometallic compound, and the formulation consists of at least 10% copper-8-quinolinolate, 10% nickel-2-ethylhexanoate, and 80% inert ingredients (AWPA P8). It is accepted as a stand-alone preservative for aboveground use for sapstain and mold control and is also used for pressure treating. A water-soluble form can be made with dodecylbenzene sulfonic acid, but the solution is corrosive to metals.

Oxine copper solutions are greenish brown, odorless, toxic to both wood decay fungi and insects, and have a low toxicity to humans and animals. Because of its low toxicity to humans and animals, oxine copper is the only EPA-registered preservative permitted by the U.S. Food and Drug Administration for treatment of wood used in direct contact with food. Some examples of its uses in wood are commercial refrigeration units, fruit and vegetable baskets and boxes, and water tanks. Oxine copper solutions have also been used on non-wood materials, such as webbing, cordage, cloth, leather, and plastics.

Zinc Naphthenate
Zinc naphthenate is similar to copper naphthenate but is less effective in preventing decay from wood-destroying fungi and mildew. It is light colored and does not impart the characteristic greenish color of copper naphthenate, but it does impart an odor. Waterborne and solvent-borne formulations are available. Zinc naphthenate is not widely used for pressure treating.

3-Iodo-2-Propynyl Butyl Carbamate
3-Iodo-2-propynyl butyl carbamate (IPBC) is a fungicide that is used as a component of sapstain and millwork preservatives. It is also included as a fungicide in several surface-applied water-repellent-preservative formulations. Waterborne and solvent-borne formulations are available. Some formulations yield an odorless, treated product that can be painted if dried after treatment. It is listed as a pressure-treatment preservative in the AWPA standards but is not currently standardized for pressure treatment of any wood products. IPBC also may be combined with other fungicides, such as didecyldimethylammonium chloride in formulations used to prevent mold and sapstain.

IPBC/Permethrin
IPBC is not an effective insecticide and has recently been standardized for use in combination with the insecticide permethrin (3-phenoxybenzyl-(1R,S)-cis, trans-2, 2-dimethyl-3-(2,2-dichlorovinyl) cycloproanecarboxylate) under the designation IPBC/PER. Permethrin is a synthetic pyrethroid widely used for insect control in agricultural and structural applications.

The ratio of IPBC to permethrin in the IPBC/PER varies between 1.5:1 and 2.5:1. The formulation is carried in a light solvent such as mineral spirits, making it compatible with composite wood products that might be negatively affected by the swelling associated with water-based pressure treatments. The IPBC/PER formulation is intended only for use in above-ground applications. The formulation is listed as a preservative in AWPA standards, but at the time this chapter was finalized it had not yet been standardized for treatment of any commodities.

Alkyl Ammonium Compounds
Alkyl ammonium compounds such as didecyldimethylammonium chloride (DDAC) or didecyldimethylammonium carbonate (DDAC)/bicarbonate (DDABC) have some efficacy against both wood decay fungi and insects. They are soluble in both organic solvents and water and are stable in wood as a result of chemical fixation reactions. DDAC and DDABC are currently being used as a component of alkaline copper quat (ACQ) (see section on Waterborne Preservatives) for above-ground and ground-contact applications and as a component of formulations used for sapstain and mold control.

4,5-Dichloro-2-N-Octyl-4-Isothiazolin-3-One (DCOI)
4,5-dichloro-2-N-octyl-4-isothiazolin-3-one (DCOI) is a biocide that is primarily effective against wood decay fungi. It is soluble in organic solvents but not in water, and it is stable and leach resistant in wood. The solvent used in the formulation of the preservative is specified in AWPA P9 Type C. DCOI can be formulated to be carried in a waterborne system, and it is currently used as a component in the waterborne preservative EL2. It has also recently been proposed for use as co-biocide in a copper ethanolamine formulation referred to as ACD.

Chlorpyrifos
Chlorpyrifos (CPF) is an organophosphate insecticide that has been widely used for agricultural purposes. It has been standardized by the AWPA as a preservative but is not currently used as a component of commercial pressure treatments.

Chloropyrifos is not effective in preventing fungal attack and should be combined with an appropriate fungicidal preservative for most applications.

Treatments for Wood Composites

Many structural composite wood products, such as glued-laminated beams, plywood, and parallel strand and laminated veneer lumber, can be pressure-treated with wood preservatives in a manner similar to lumber. However, flake- or fiber-based composites are often protected by adding preservative during manufacture. A commonly used preservative for these types of composites is zinc borate. Zinc borate is a white, odorless powder with low water solubility that is added directly to the furnish or wax during panel manufacture. Zinc borate has greater leach resistance than the more soluble forms of borate used for pressure treatment and thus can be used to treat composite siding products that are exposed outdoors but partially protected from the weather. Zinc borate is currently listed in AWPA Commodity Standard J for non-pressure treatment of laminated strand lumber, oriented strandboard, and engineered wood siding. The standard requires that these products have an exterior coating or laminate when used as siding. Another preservative that has been used to protect composites is ammoniacal copper acetate, which is applied by spraying the preservative onto the OSB flakes before drying.

Fire Retardant Treated

This treated wood utilizes a fire retardant chemical that remains stable in high temperature environments. The fire retardant is applied under pressure at a wood treating plant like the preservatives described above, or applied as a surface coating.

In both cases, treatment provides a physical barrier to flame spread. The treated wood chars but does not oxidize. Effectively this creates a convective layer that transfers flame heat to the wood in a uniform way which significantly slows the progress of fire to the material. There are several commercially available wood-based construction materials using pressure-treatment (such as those marketed in the United States and elsewhere under the trade names of 'Dricon', 'D-Blaze,' and 'Pyro-Guard', as well as factory-applied coatings under the trade names of 'PinkWood' and 'BluWood'. Some site-applied coatings as well as brominated fire retardants have lost favor due to safety concerns as well as concerns surrounding the consistency of application. Specialized treatments also exist for wood used in weather-exposed applications.

Toxic Oil-borne Preservatives

These include pentachlorophenol and creosote. They are toxic, have an unpleasant odor and are generally not used in consumer products.

Coal-tar Creosote

Creosote is a tar-based preservative that has been commonly used for telephone poles and railroad ties. Creosote is one of the oldest wood preservatives, and was originally derived from a wood distillate. These days virtually all creosote is manufactured from the distillation of coal tar. It often collects inside chimneys and may cause a fire hazard.

Creosote is regulated as a pesticide and is not usually sold to the general public. It is still used for railroad ties (also called railway sleepers and cross ties) and utility poles.

Linseed Oil
Linseed oil is used to preserve Wood fences, log cabins, and wood furniture. (Such woods as Willow, Pine, oak and exc.) The function of linseed oil as a preservative is believed to be related to its action as a water repellent and drying agent rather than a direct biocidal activity.

A number of companies have developed natural-oil-only-based treatments; no synthetic preservative such as permethrin is added. Menz Holz OHT use autoclave impregnation with linseed, sunflower and rapeseed oil for 6 to 8 hours.

Naphthenic Acid
Naphthenic acid is the name for an unspecific mixture of several cyclopentyl and cyclohexyl carboxylic acids with molecular weight of 120 to well over 700 atomic mass units. The main fraction are carboxylic acids with a carbon backbone of 9 to 20 carbons. The naphtha fraction of the crude oil refining is oxidized and yields naphthenic acid. The composition differs with the crude oil composition and the conditions during refining and oxidation. Naphthenic acids are present in crude oil and leads to corrosion problems within the oil refineries; therefore "naphthenic acid corrosion" phenomena are well researched. Crude oils with a high content of naphthenic acids are often referred to as high TAN (Total Acid Number) crude oils or high acid crude oil (HAC). There is also a conference called the High TAN Crude Conference which was first organized in 2005.

Mixtures of a flammable substance and naphthenic and palmitic acid aluminum salts were discovered during World War II to make napalm. These acids caused flammable hydrocarbons to gel.

Other uses of naphthenic acids depend on the refinement of the material. Naphthenic acid is used in corrosion inhibitors, wood preservatives, lubricant and fuel additives, driers for paints and inks, and in the production of metal soaps.

Naphthenates
Naphthenates are the salts of naphthenic acids. These salts have industrial applications including synthetic detergents, lubricants, corrosion inhibitors, fuel and lubricating oil additives, wood preservations, insecticides, fungicides, acaricides, wetting agents, and oil drying agents used in painting and wood surface treatment.

Industrially useful naphthenates include barium naphthenate, calcium naphthenate, cobalt naphthenate, copper naphthenate, lead naphthenate, magnesium naphthenate, manganese naphthenate, nickel naphthenate, sodium naphthenate, vanadyl naphthenate and zinc naphthenate.

2017 Changes to EPA's Farm Worker Protection Standard
In late 2015 the Environmental Protection Agency issued the long awaited revision to the Worker Protection Standard (WPS). This law it is now technically active and it will be enforced. Please keep in mind that the WPS covers both restricted use AND general use pesticides. This course is not for worker and/or handler training. Always follow the label and your State Pesticide Agency rules.

This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

Other Wood Preservative Emulsions

Light Organic Solvent Preservatives (LOSP)
This class of timber treatments use white spirit, or light oils such as kerosene, as the solvent carrier to deliver preservative compounds into timber. Synthetic pyrethroids are typically used as an insecticide, such as permethrin, bifenthrin or deltamethrin. The most common formulations use Permethrin as an insecticide, and Propaconazole and Tebuconazole as fungicides. While still using a chemical preservative, this formulation contains no heavy-metal compounds.

With the introduction of strict volatile organic compound (VOC) laws in the European Union, LOSPs have disadvantages due to the high cost and long process times associated with vapor-recovery systems. LOSPs have been emulsified into water-based solvents. While this does significantly reduce VOC emissions, the timber swells during treatment, removing many of the advantages of LOSP formulations.

This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

New Technologies
Glass Fortified Wood
Glass Fortified Wood (glass wood) is lumber that has gone through a process that intermixes a non-toxic sodium silicate (water glass) based formula throughout the wood fibers protecting the wood from fire, rot and insect damage. With glass encapsulating the wood fibers, the lumber becomes harder and the strength is increased. Glass wood can be used for in ground contact applications, in water applications and it is Class-A fire retardant.

Wood Acetylation
Chemical modification of wood at the molecular level has been used to improve its performance properties. Many chemical reaction systems for the modification of wood, especially those using various types of anhydrides, have been published; however, the reaction of wood with acetic anhydride has been the most studied.

The physical properties of any material are determined by its chemical structure. Wood contains an abundance of chemical groups called free hydroxyls. Free hydroxyl groups readily absorb and release water according to changes in the climatic conditions to which they are exposed. This is the main reason why wood's dimensional stability is impacted by swelling and shrinking. It is also believed that the digestion of wood by enzymes initiates at the free hydroxyl sites - which is one of the principal reasons why wood is prone to decay.

Acetylation effectively changes the free hydroxyls within wood into acetyl groups. This is done by reacting the wood with acetic anhydride, which comes from acetic acid (the main component of vinegar).

When free hydroxyl groups are transformed to acetyl groups, the ability of the wood to absorb water is greatly reduced, rendering the wood more dimensionally stable and, because it is no longer digestible, extremely durable. In general, softwoods naturally have an acetyl content between 0.5 to 1.5% and more durable hardwoods between 2 to 4.5%. Acetylation takes wood well beyond these levels with corresponding benefits. These include an extended coatings life due to acetylated wood acting as a more stable substrate for paints and translucent coatings. Acetylated wood is non-toxic and does not have the environmental issues associated with traditional preservation techniques.

The acetylation of wood was first done in Germany in 1928 by Fuchs. In 1946, Tarkow, Stamm and Erickson first described the use of wood acetylation to stabilize wood from swelling in water. Since the 1940s, many laboratories around the world have looked at acetylation of many different types of woods and agricultural resources.

In spite of the vast amount of research on chemical modification of wood, and, more specifically, on the acetylation of wood, commercialization did not come easily. The first patent on the acetylation of wood was filed by Suida in Austria in 1930. Later, in 1947, Stamm and Tarkow filed a patent on the acetylation of wood and boards using pyridine as a catalyst. In 1961, the Koppers Company published a technical bulletin on the acetylation of wood using no catalysis but with an organic co-solvent. In 1977, in Russia, Otlesnov and Nikitina came close to commercialization but the process was discontinued presumably because cost-effectiveness could not be achieved. In 2007 a London-based company, with production facilities in The Netherlands, achieved cost-effective commercialization and began large-scale production of acetylated wood.

Although many decay fungi may grow for long periods without producing any external evidence of their presence, others produce "fruiting bodies" on the surface of decaying wood. Fruiting bodies are usually "crusts" or shelf-like "brackets" which are a few inches or so in diameter.

This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

More on Preventing Termite Infestations

The most effective and least expensive means of protecting buildings from the subterranean termite is to prevent infestations from developing in the first place. This includes eliminating existing colonies and potential food sources of colonies in the vicinity of new construction.

New Construction
New construction should also be pretreated with a soil termiticide prior to laying of concrete foundations and slabs. The surrounding grounds should be made less susceptible to infestation from expanding colonies by eliminating stumps and logs in the vicinity. Termites will readily tunnel through expanded (EPS) and extruded (XPS) polystyrene. These materials can lead to serious termite problems when used as exterior cladding below grade and such use is not recommended in areas where termites are common.

Mud Tube Removal
State regulations require pest control operators to remove termite tubes as part of a complete termite treatment. Removing the tubes provides a way to determine if a termite infestation remains active after treatment or if the termites reappear in the same area later. Scraping away mud tubes as the sole means of control can be impractical and is probably unwise in many cases (such as with slab construction). The tubes are an indication that termites are active around the house. What you cannot easily determine, even with a careful inspection, is whether termites may be active in a foundation or wall void or some other visually inaccessible area of your home.

Debris Removal
Although it is convenient, it is not a good idea to turn your crawlspace into a general storage area, particularly for items made of wood, cardboard or paper that can serve as food for termites. The same problem arises when tree stumps are left under houses during construction. State regulations require that termite treatments include the removal of cellulose debris of a size that can be removed with an ordinary garden rake. Removing the debris helps reduce food resources that could be used by termites. This topic is discussed under preventive measures.

Garage doorframes are often vulnerable to moisture and termite problems.

The following precautionary practices will discourage termite infestations.

1. Building sites should be cleared of stumps, roots or other woody material that remains beneath or adjacent to the building.
2. All stakes, forms (including those under concrete steps, cement slabs and pads) and building debris should be removed from beneath and adjacent to buildings. Do not backfill over such debris.
3. The site should be well drained so that moisture is not retained under, or adjacent to, a building. Downspouts should carry water away from the building.
4. Crawl spaces should be accessible, well ventilated and high enough to allow working space. Insufficient clearance also makes easy construction of termite shelter tubes from soil to wood. Make sure air flow through vents is not blocked by shrubbery or other materials.
5. Crawl spaces and basements should be kept clear of lumber, firewood, sawdust and other woody materials.
6. No wood (stair supports, posts or other wood) should project through concrete floors or foundations.
7. Foundations should be of concrete or masonry, and soil debris should be kept clear of wood resting on them. Make sure the foundation wall is high enough to allow sufficient top soil placement and still leave at least 15-20 cm of clearance between the bottom of siding or stucco and the ground.
8. Slabs, concrete floors and foundation joints should be sealed against moisture, and regularly inspected for cracks which should be immediately sealed.
9. Outside structures such as fences, railings, wooden planters, wooden sidewalks and stumps or trees should be well separated from houses or other buildings. Metal flashing can be installed to prevent the passage of termites. Most wood preservatives will discourage termites.
10. Do not stack firewood next to buildings, especially those with wood siding.
11. Avoid placing wood chips or bark mulch adjacent to the foundation. Use lava or other rock instead.
12. Avoid over-watering lawns and regularly check for leaks in underground irrigation systems and dripping faucets. This will also aid in discouraging leatherjacket (crane fly) infestations in lawns.

Buildings should be checked at least once a year for necessary maintenance of the above items and unsatisfactory conditions should be corrected. Surrounding grounds should be inspected for termites using wooden stakes and remedial action taken to prevent further spread of termites where detected.

During the construction phase, various methods have been developed to discourage termite infestations. These include appropriate placement of metal flashing or shields between the cement foundation the wooden structure, ensuring expansion joints are properly cured and that no spaces exist around utility pipes (sewer, electricity, natural gas lines) cut through the foundation or slab.

Control products containing inorganic borate can be applied to lumber at the time of construction, or later if exposed, to provide lifetime protection from infestation as long as the wood remains dry.

Remedial Control

Control of subterranean termites in buildings can be difficult and expensive. Chemical (termiticide) treatment is a proven means of protecting buildings from further damage by subterranean termites. The majority of treatments involves injection of a termiticide around the entire perimeter of the foundation and under the slab (called a full treatment) or may only require a partial treatment of the perimeter if the infestation is very localized. Some termiticides can be sprayed if the infestations are suited to this type of treatment. Therefore, as previously mentioned, it is important that a correct diagnosis and thorough inspection be made before any control measures are implemented.

This is best done through the services of a professional licensed pest control applicator, preferably someone with specialized knowledge and experience in termite control. Because it takes a long time for termites to cause appreciable damage, there is rarely need for immediate control action. Therefore, building owners should take the time to contact at least three operators to compare their diagnoses and competitive bids for the job.

A reliable pesticide applicator should provide the owner with a diagram of the inspected premises, indicating the points of entry and the location and the severity of infestations, and an estimate of the control costs along with an explanation of how the control measures are to be carried out. Be sure to give a written guarantee on the length of protection (usually years) the treatment will provide. Owners with buildings having hot-water heated basement floors should provide a diagram of the pipe layout if the floor is to be drilled to inject a termiticide under the slab.

Sodium Borate

Sodium Borate has been a popular alternative treatment for subterranean termites in the last few years. Popularized in the early 1990's with the advent of **BORACARE** (Sodium Borate and Glycol which acts as a penetrate), Sodium Borate is a form of Boric Acid, although it is not as refined as Boric Acid, but comes from the same basic element boron.

Sodium Borate acts by killing the bacterial protozoa in the termites' intestinal gut which acts as the termites' food processor. This bacterial protozoa actually digests the wood which the termite eats, and processes it into an energy source (sugar); the termite then excretes a wood pellet (frass).

When the termites digest wood containing sodium borate, the bacterial protozoa is killed which results in the termites not being able to digest their food. So, in essence, the termite starves to death.

Sodium Borate is relatively inexpensive and is widely used in the termite control industry as a secondary backup treatment to a conventional soil treatment. Sodium Borate can also be used as a termite bait, and also as flea killer for carpets.

Timbor is easy to mix and apply. 1 lb. of Timbor mixes in 1 gallon of water--simply spray Timbor with a hand sprayer or apply liberally with a paint brush, roller etc., to barewood surfaces such as wall studs, joists, etc.

Timbor will saturate the wood and provide many years of protection against termites, carpenter ants, wood decay fungi, etc. Timbor is an excellent protection and is highly recommended.

New Methods of Termite Control

New methods of termite control are always being developed by researchers. Some examples include baits, sand barriers, the fungal pathogen Metarhizium anisopliae, and transmissible coatings.

One of my favorite treatment products but there are many others on the market. Always follow the instructions and please wear proper PPE.

The photograph above is of a tropical termite nest will often house parrots. The parrots will enter through the bottom and the young will eat the termite larva. Funny to say, but many of us in California and Arizona are dealing with parrots as a pest. We will tackle this subject in a future course.

The FST attacks structural lumbers and living plants because they are sources of cellulose. A single colony of C. formosanus may produce over 70,000 alates. After a brief flight, alates shed their wings.

Females immediately search for nesting sites with males following closely behind. When the pair finds a moist crevice with wooden materials, they form the royal chamber and lay approximately 15 to 30 eggs.

Within two to four weeks, young termites hatched from the eggs. The reproductives nurse the first group of young termites until they reach third instar.

One to two months later, the queen lays the second batch eggs which would be eventually nursed by termites from the first egg batch. It may take three to five years before a colony reach substantial number to cause severe damage and produce alates.

A mature colony contains distinct groups called castes. These castes look different from one another and each has a special duty within the colony. The king and queen are the primary reproductives and are responsible for reproduction. If the queen or king dies or the colony becomes large, secondary reproductives may form and begin reproduction. Soldiers defend the colony against predators and other natural enemies. Workers take care of and feed the larvae, reproductives and soldiers, tend the eggs, build and maintain the nest, and search for food. Alate nymphs become alates when they are fully grown.

Formosan termite swarms usually occur from April through July on calm, warm, and humid evenings. Swarms are quite large with up to tens of thousands of alates. The swarmers are attracted to lights and are often found around windows, light fixtures, windowsills, and spider webs in lighted areas.

After swarming and landing on the ground, the alates break off their wings and search for a mate. Once a mate is found the male and female search for a crevice in damp ground or wood, hollow out a small chamber, and crawl inside. The pair, now known as the king and queen, mate and within a few days the queen starts laying eggs. The young, known as larvae, hatch from the eggs and are fed by the king and queen.

Termite and Wood Destroyer Management Post Quiz

1. Permethrin is a narrow-spectrum pyrethroid insecticide.
True or False

Borates
2. “Borate” is a generic term for compounds containing the elements boron and?

Pyrroles
3. Chlorfenapyr is registered as a termiticide under which tradename?

Fiproles (or Phenylpyrazoles)
4. Fipronil is the only insecticide in this new class, introduced in 1990 and registered in the U.S. in 1996. It is marketed as a termiticide under which tradename?

Crawl Spaces
5. Do not treat soil in crawl space area with a broadcast insecticide spray. Establish vertical barriers by rodding and/or trenching procedures. A shallow trench should not be wider than 6 inches. Space rod holes about 1 to 1 1/2 feet apart. Apply insecticide at the rate of 4 gallons per 10 linear feet per foot of depth.
True or False

Bath Traps
6. Soil may require insecticide treatment if it is exposed beneath and around plumbing/waste pipe entrances through a concrete slab. Remove any wood or other debris and treat the soil by rodding or flooding with an insecticide solution.
True or False

Treatment of Secondary Subterranean Termite Colony
7. Apply insecticide to infested wood and void spaces with a crack and crevice injector.
True of False

New Construction
8. Termites will readily tunnel through expanded (EPS) and extruded (XPS) polystyrene. These materials can lead to serious termite problems when used as exterior cladding below grade and such use is not recommended in areas where termites are common.
True or False

9. Which action provides a way to determine if a termite infestation remains active after treatment or if the termites reappear in the same area later?

10. During which phase, various methods have been developed to discourage termite infestations? These include appropriate placement of metal flashing or shields between the cement foundation the wooden structure, ensuring expansion joints are properly cured and that no spaces exist around utility pipes (sewer, electricity, natural gas lines) cut through the foundation or slab.

Post Quiz Answers Termite and Wood Destroyer Management Answers
1. False, 2. Oxygen 3, Phantom®, 4. Termidor®, 5. True 6. True 7. True 8. True 9. Removing the tubes, 10. Construction phase

Topic 8- Major Wood Destroyer Threats- Beetles

Section Focus: You will learn the basics of wood destroyers with an emphasis on beetles, including the life cycle, behavior and related scientific information. At the end of this section, you the student will be able to understand and describe general information about the various wood destroyers including beetles, including the life cycle and related information. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Homes are threatened by several types of wood destroying insects including: Bark Beetles, Powderpost Beetles, Termites and Carpenter Ants. These wood destroying insects often go undetected, causing extensive damage to homes before evidence of their presence is known. Each beetle or pest type requires a specific treatment approach.

Proper Identification of Wood Destroying Pests

POWDERPOST BEETLES

1. In processed wood, numerous small holes less than 3/ 8 inch in diameter. If the piece is split open, many frass-filled tunnels can be seen, most of them running with the grain. Family Bostrichidae (branch and twig borers, bostrichid beetles, horned powderpost beetles)

2. Exit holes 1/ 16 to 1/8 inch in diameter. More advanced galleries running across the grain. Frass consists in part of distinct elongate or bun-shaped pellets. In hard- and softwoods. Family Bostrichidae (branch and twig borers, bostrichid beetles, horned powderpost beetles)

3. Exit holes vary from 1/ 8 to 3/8 inch in diameter. Occasional tunnels go across the grain but mostly with the grain. Fine or coarse frass that tends to stick together; few if any pellets. In hardwoods such as ash, oak, and hickory; sometimes in softwoods. Family Anobiidae (**drugstore** and deathwatch beetles) Live in dry vegetable materials; some species destructive pests; examples Xestobium, Stegobium, Lasioderma; about 1,100 widely distributed species.

4. Exit holes 1/32 to 1/16 inch in diameter in newer or poorly seasoned hardwood lumber. (Common in poorly seasoned lumber.) Frass in tunnels is loose and powdery and contains no pellets. *Family Lyctidae* Powderpost beetles are a group of seventy species of woodboring beetles classified in the insect subfamily Lyctinae. These beetles, along with spider beetles, death watch beetles, common furniture beetles, skin beetles, and others, make up the superfamily Bostrichoidea. While most woodborers have a large prothorax, powderpost beetles do not, making their heads more visible. In addition to this, their antennae have two-jointed clubs.

LONGHORNED BEETLE

5. In either processed wood or rough timber, occasional holes, round or elliptical, 1/4 to 1/2 inch in diameter. Irregular and rather extensive tunnels in the sapwood with usually coarse, packed frass.

Longhorned beetles - Asian longhorned beetle, (**Anoplophora glabripennis**), also spelled Asian long-horned beetle, also called starry sky beetle, species of beetle (order Coleoptera, family Cerambycidae), originally native to eastern China and Korea, that became a serious pest of hardwood trees in North America and parts of Eurasia.

6. Usually heavy damage of this sort in finished wood. Often the only external evidence of damage is one or two oval exit holes. *Old house borer*

OLD HOUSE BORER

7. In rough, bark-covered wood, small exit holes about 1/8 inch in diameter. Inner side of bark and surface of wood itself “engraved” with galleries (old damage; can’t re-infest dried wood; no control required). *Bark beetle*

BARK BEETLE

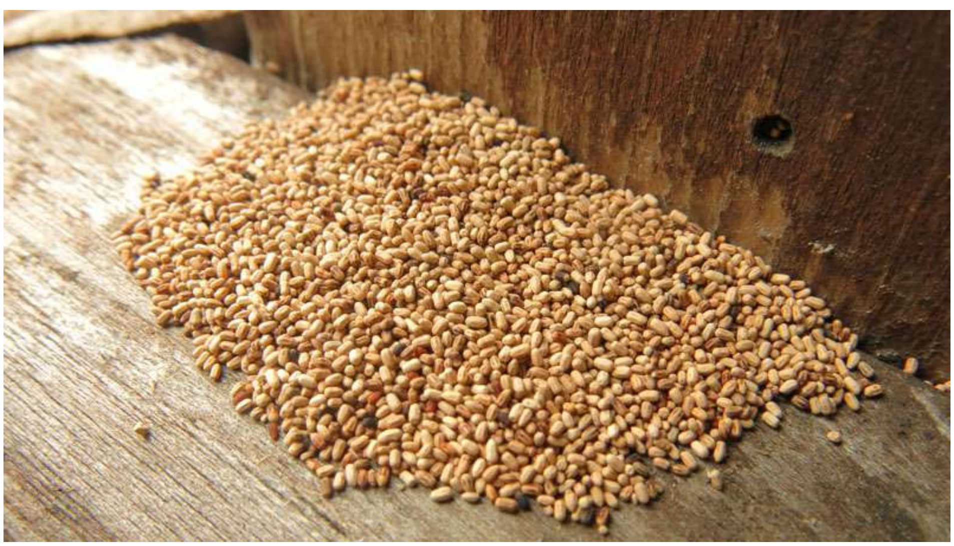
8. Pinholes and slender galleries in sapwood, frequently of southern yellow pine. The burrows and area around them stained dark by the action of fungi (old damage, can't re-infest dried wood; no control required). *Ambrosia beetle* - Ambrosia beetles are beetles of the weevil subfamilies Scolytinae and Platypodinae, which live in nutritional symbiosis with ambrosia fungi. The beetles excavate tunnels in dead or stressed trees in which they cultivate fungal gardens, their sole source of nutrition. After landing on a suitable tree, an ambrosia beetle excavates a tunnel in which it releases spores of its fungal symbiont. The fungus penetrates the plant's xylem tissue, extracts nutrients from it, and concentrates the nutrients on and near the surface of the beetle gallery. Ambrosia fungi are typically poor wood degraders, and instead utilize less demanding nutrients. The majority of ambrosia beetles colonize xylem of recently dead trees, but some attack stressed trees that are still alive, and a few species attack healthy trees. Species differ in their preference for different parts of trees, different stages of deterioration, and in the shape of their tunnels. However, the majority of ambrosia beetles are not specialized to any taxonomic group of hosts, unlike most phytophagous organisms including the closely related bark beetles. One species of ambrosia beetle, Austroplatypus incompertus exhibits eusociality, one of the few organisms outside of Hymenoptera and Isoptera to do so.

AMBROSIA BEETLE

9. No openings (or very few and these are usually sealed over). Extensive galleries run lengthwise, usually in the springwood, and are packed with a hard, mastic-like frass. May infest many old cellulose objects near or in contact with the soil. *Subterranean termites*

SUBTERRANEAN TERMITES

10. Distinct round openings to outside of wood; when split open, it reveals very thorough excavation. Galleries contain considerable amounts of coarse, hard, sandlike frass, each pellet having rounded ends and six longitudinal depressions. No mastic-like frass or very fine powder. *Drywood termites*



DRYWOOD TERMITE FRASS

CARPENTER ANTS

11. Timbers with extensive galleries that are sandpaper smooth, often with rounded edges, and contain no frass. Coarse sawdust may be found near damage. *Carpenter ants*

CARPENTER BEE AND DAMAGE

12. Wood with 1/3- to 1/2-inch round holes on side, edge or end, leading into long tunnel (3 to 24 inches). If hole is on side of wood, tunnel turns at right angles and continues with the grain of the wood. *Carpenter bees*

Adapted from a release by Department of Entomology, Purdue University, West Lafayette, Ind.

Evidence of Longhorned beetles in above photo.

Evidence of Carpenter bee in above photo. Note Woodpeckers do not drill holes longer than their beaks. Woodpecker are great wood destroyers, even on the sides of houses but the damage is only about 1 inch deep. You will probably go to prison if you try to control a woodpecker. Endanger species act and wildlife regulations are very strict.

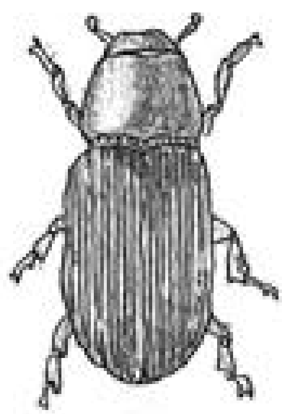
Evidence of Powder post beetles in above photo.

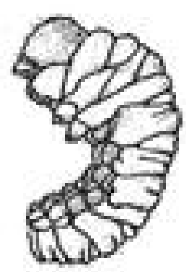
The term "carpenter ant" is applied broadly to several species of ants that nest in or around wood. Our concern is with ants in the genus, *Camponotus*. Some of these species actually tunnel into the wood, while other species prefer to nest in existing cavities. These make an oval shape cut in the wood.

Wood Borers Insect Identification Sub-Section

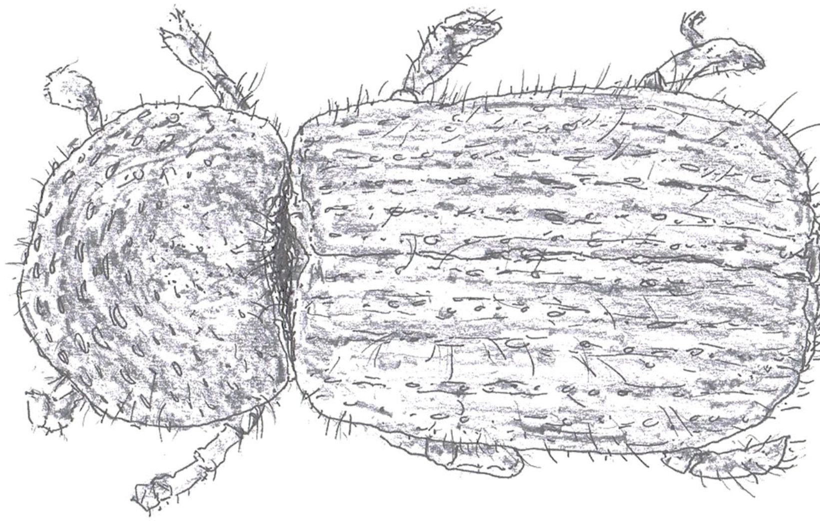
BARK BEETLE (ADULT)

Bark beetle adult
Although not true borers, bark beetles attack several evergreen trees. The adults usually emerge in mid-summer and lay eggs.



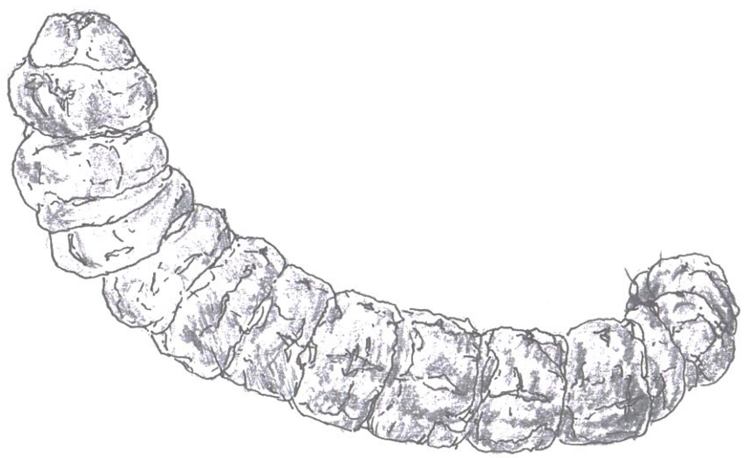


Bark beetle larvae
The larvae are legless grubs that feed just under the bark. Enough larvae can girdle a tree. In affected trees, the tops turn red then yellow and brown. Different species can be determined by the shape of the gallery in some cases.



SHOT HOLE BORER (ADULT)

Shot-hole borer adult
Shot hole borers attack weakened or dead trees and shrubs. They feed deeper in the wood than bark beetles. The larvae are legless grubs. Many emergence holes are often present where several adults have emerged. Thus, the "*shot hole*" appearance on affected trees.

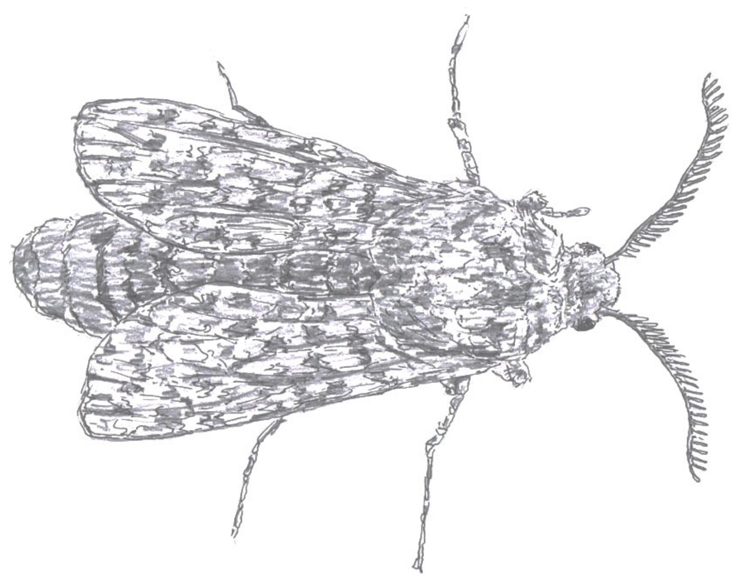


CARPENTER WORM LARVAE

Carpenter worm larva
Carpenter worms are large caterpillars that grow to almost three inches long. They mine the heart wood of trees. They attack poplars and cottonwoods and can attack many other trees as well.

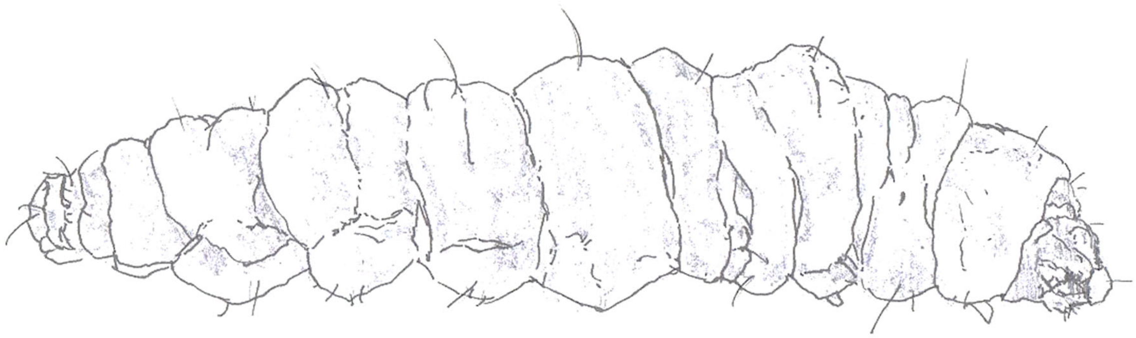
CARPENTER WORM MOTH (ADULT)

Carpenter worm adult
The adult carpenter worm is a large grey moth.



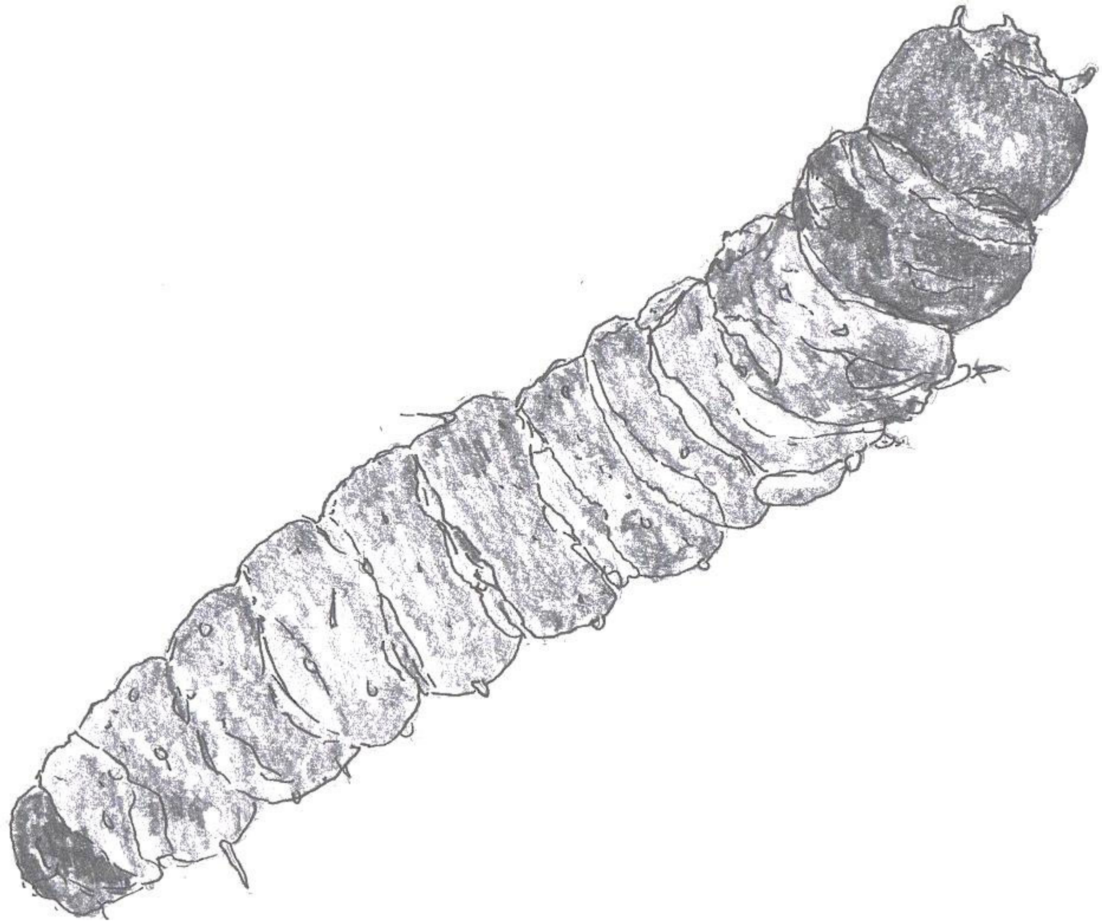
CLEAR WINGED MOTH

Clear-winged moth adult
Many clear-winged moths bore in trees as larvae. The adults resemble wasps in many cases.



CLEAR WINGED MOTH LARVAE

Clear-winged moth larva
The caterpillars of clear-winged moths can extensively mine limbs of susceptible trees. Poplars, willow, and cottonwood trees are hosts of several species.



PEACH TWIG BORER (LARVAE)

Peach twig borer larva
The peach twig borer is a pest because it mines in the ends of the new twigs of fruit trees and ornamental fruit trees. The new twigs start to grow and then wilt because these larvae are tunneling down the center of them. Adults are small grey moths.

Borers are a major problem for ornamental trees. Once infested, there is little that can be done to control the insects in the wood. Thus, keeping trees as healthy as possible is the best way to prevent borer damage.

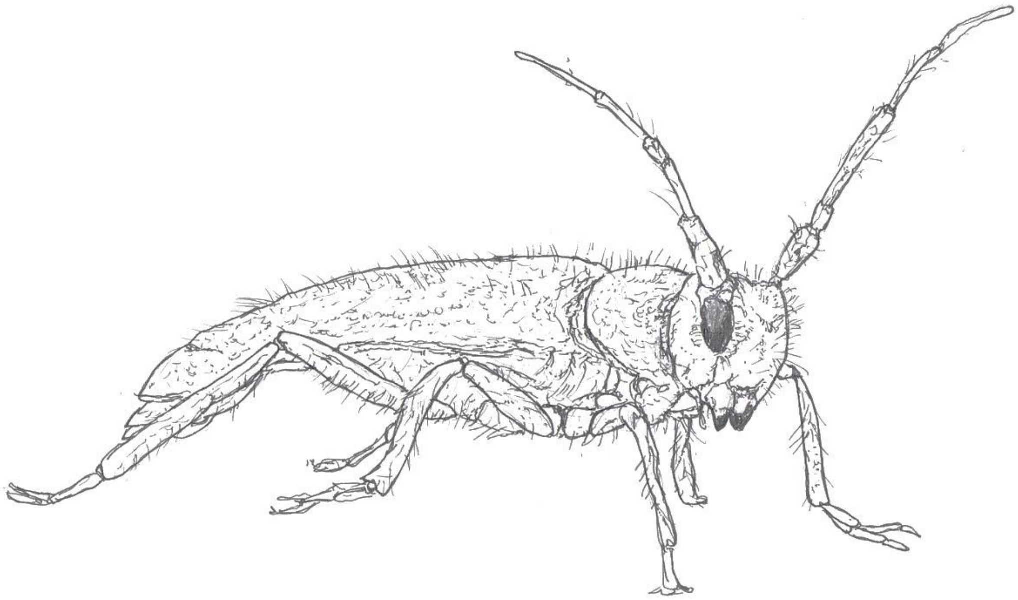
Trees that are old, drought stressed or otherwise unthrifty are most likely to be successfully attacked by borers. Most of the borers we encounter are beetles but some are caterpillars of clear winged or other moths and others are primitive wasps.

POPLAR & WILLOW BORER (ADULT)

Poplar and willow borer adult
These weevils emerge around August and lay eggs in stems at least 1" in diameter. It does not attack quaking aspen but a similar borer does.

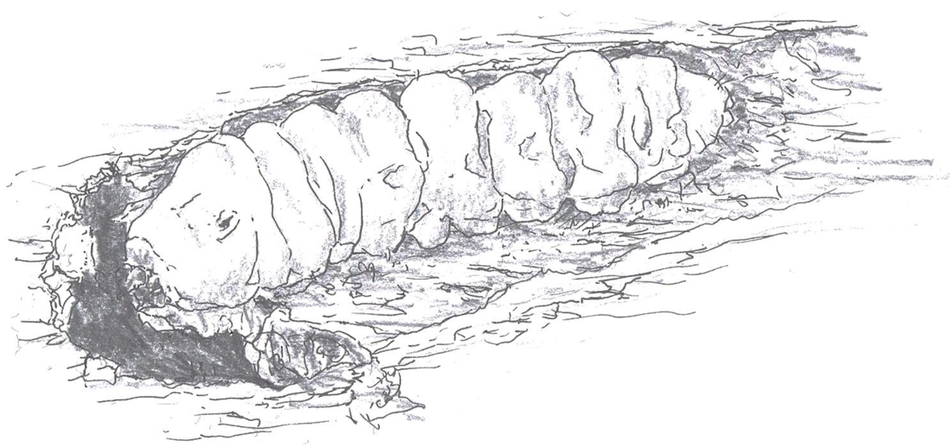
POLAR BORER (LARVAE)

Poplar and willow borer larva
The larvae mine the sapwood. Swollen areas on limbs show where the larvae feed and frass can be seen being forced out of holes in the bark as the larva feeds.



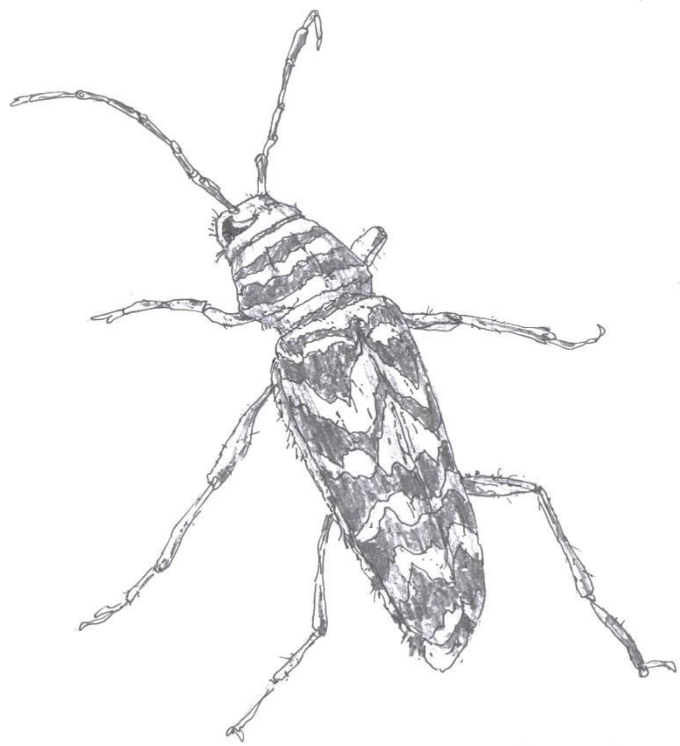
POPLAR BORER (ADULT)

Poplar borer adult
Poplar borers are a serious pest of poplar. Adults emerge and are around from June through August.



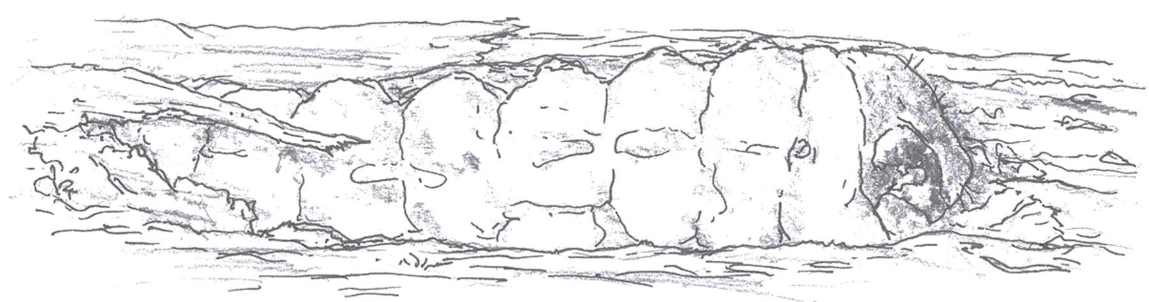
POPLAR BORER LARVAE AND DAMAGE

Poplar borer larva
Most of the life cycle is spent as the larva in the tree. They feed for a period of 2-4 years and bore in the heartwood and sapwood. Infested trees can be weakened and break. A related species causes galls on smaller limbs of poplars and aspens.



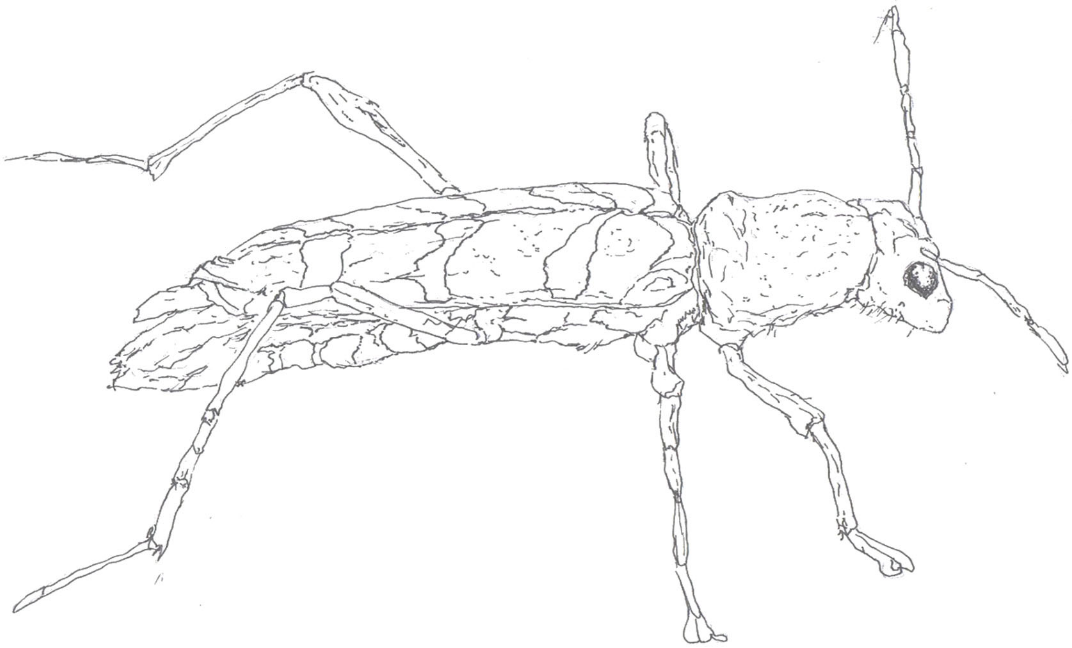
LOCUST BORER (ADULT)

Locust borer adult
Locust borers attack black locust trees. The strikingly colored adults emerge in the fall and can be seen feeding on goldenrod.



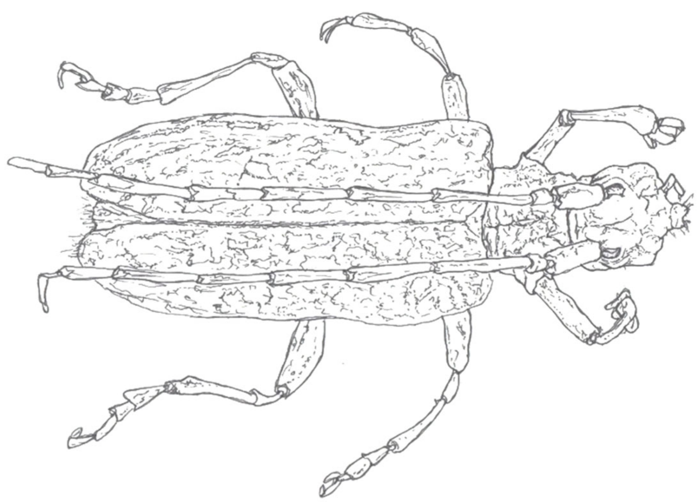
LOCUST BORER LARVAE AND DAMAGE

Locust borer larva
A year is required for the larva to develop in the locust tree. Severe damage can occur from the larval feeding.



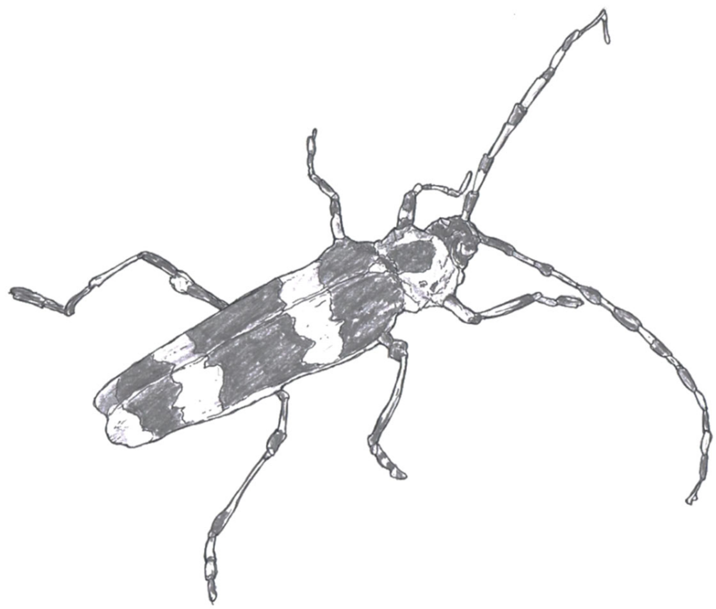
RED HEADED ASH BORER (ADULT)

Red headed ash borer adult
The red headed ash borer commonly infests ash. The larvae look like those of the locust borer only smaller. It will attack elm, linden, redbud, and oak as well as ash trees.



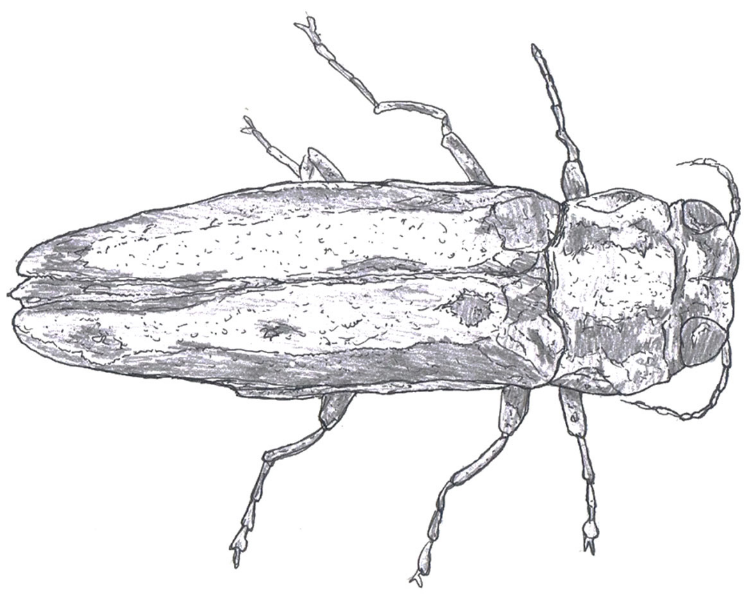
PINE SAWYER (ADULT)

Pine sawyer adult
Pine sawyers attack pine trees and are usually found around homes as a result of being brought in with firewood. They seldom attack pine trees in residential plantings.



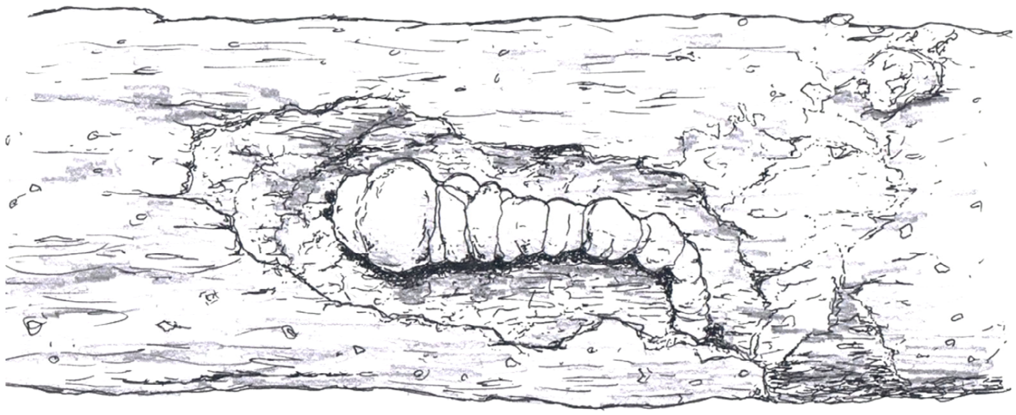
CALIFORNIA LAUREL BORER (ADULT)

California laurel borer adult
This striking insect, the California laurel borer, mines in dead ash, laurel, and willow. It is not a threat to healthy trees.



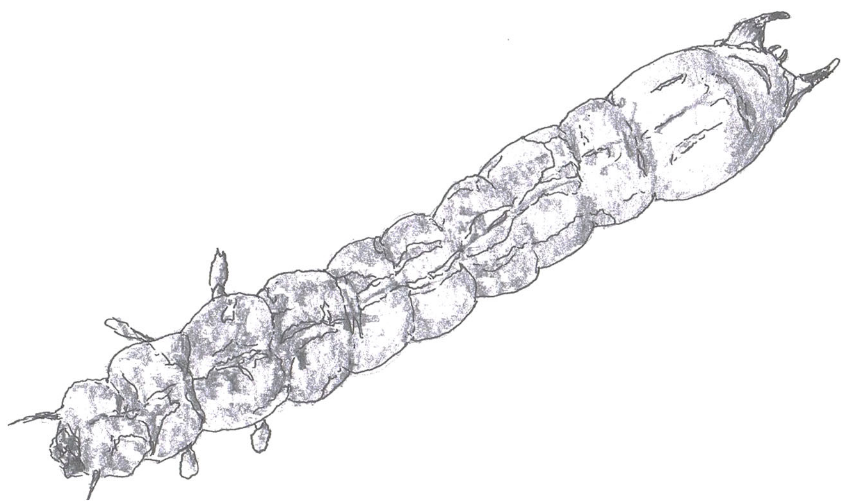
BRONZE BIRCH BORER (ADULT)

Bronze birch borer adult
Paper birches are frequently attacked by the bronze birch borer. Adults emerge in June and lay eggs in July. Note they have shorter antennae and a different shape than the borers discussed above.



BRONZE BIRCH BORER LARVAE

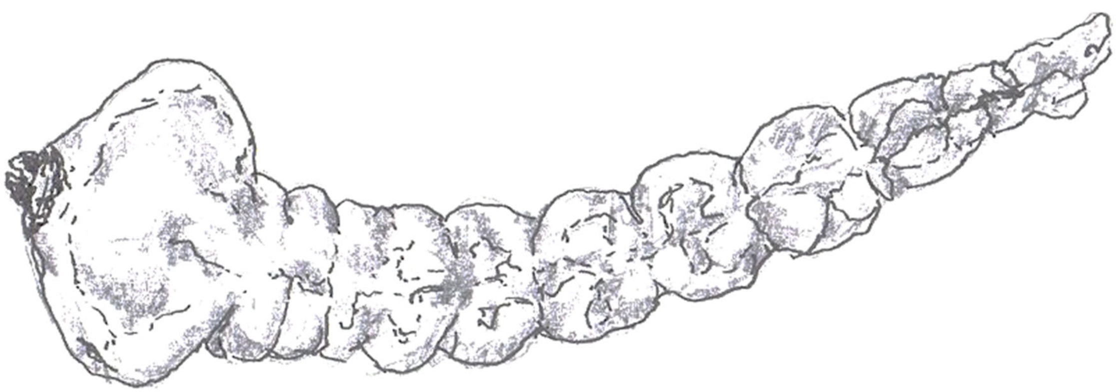
Bronze birch borer larva in limb
Most of the two-year life cycle is spent in the larval stage tunneling in the wood of birch trees. The larvae have a flattened area just behind the head which is characteristic of the flat headed borers. Damage symptoms are usually expressed by some upper limbs of the tree turning yellow and then dying.



BARK BEETLE LARVAE

PACIFIC FLATHEAD BORER (ADULT)

Pacific flatheaded borer adult
There are about 100 species of flatheaded borers represented here by the pacific flatheaded borer. This insect attacks many fruit and ornamental trees and shrubs.



PACIFIC FLATHEAD BORER LARVAE

Pacific flatheaded borer larva
Borers of this type have the typical larval shaped pictured here.

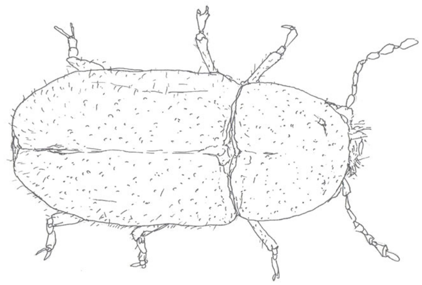
Wood Destroying Beetle Sub-Section

Many insect pests are encouraged to take up residence in wooden structures by excessive moisture conditions. Termites particularly - the dampwood termites and subterranean termites, require moisture in their living quarters. Subterranean termites provide moisture for themselves by bringing moisture and soil up from their subsurface colonies and placing it within the wood as they feed on it or around the outside of wood to form their enclosed runways. In some cases, subterranean termites may be found separated from soil contact when sufficient moisture, in the form of water leaks, is found inside a structure.

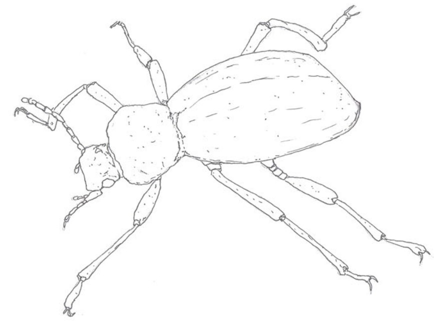
The retention of moisture is not the only important water-related factor in the life of the termite. The warm, moist conditions that prevail within the closed system of the nest provide an ideal site for the growth of microorganisms, particularly fungi, which provide a source of protein and vitamins essential to the termite. The accumulation of termite fecal material in the nest, in turn, helps to promote the growth of the fungi. The most striking fact of this intricately interdependent system is the delicacy with which it is balanced. It is not uncommon to discover the remains of a termite colony that is slowly being crowded out by the growth of fungi that has for some reason progressed at such a rate that the termites could not keep up with it. If sudden temperature shifts or other factors result in the accumulation of water within the galleries, the termites may drown. A number of beetles are associated with excessive moisture and fungus problems in structures.

The furniture beetle, an anobiid beetle, is commonly attracted to moisture and fungus. Anobiid larvae eat the wood, and the beetle may re-infest over many generations, reducing the wood to little more than powder. Anobiid larvae will not survive in wood with a moisture content below 12 percent. The drier the wood, the slower their growth. Other families of beetles are also associated with excessive moisture in structures, but with all these families, it is the fungus growth to which they are attracted.

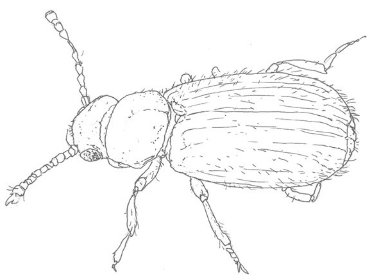
ANOBIID POWDERPOST BEETLE



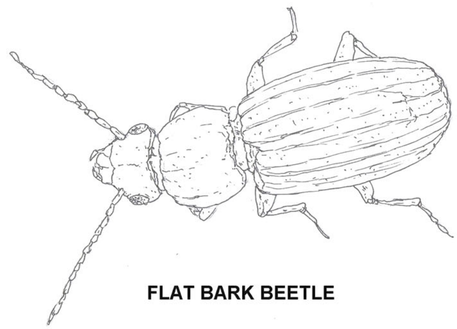
MINUTE FUNGUS BEETLE



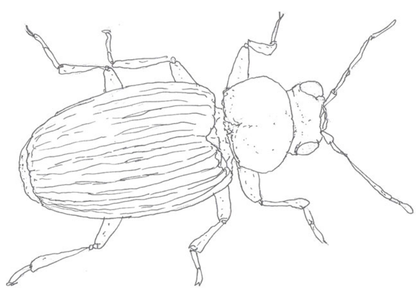
DARKLING BEETLE



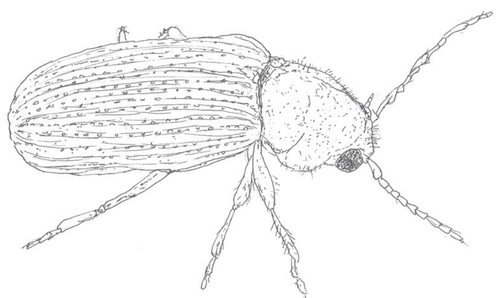
SILKEN FUNGUS BEETLE



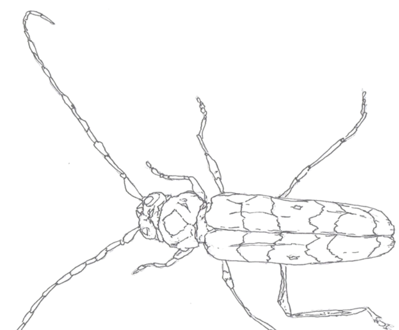
FLAT BARK BEETLE



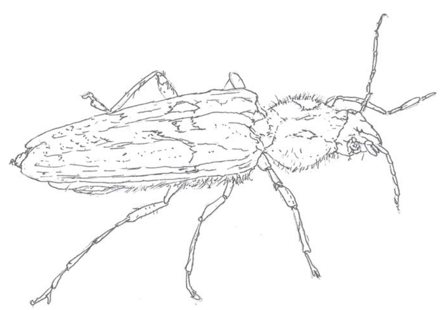
MINUTE BROWN SCAVENGER BEETLE



DEATHWATCH BEETLE



BANDED ALDER BORER



OLD HOUSE BORER BEETLE

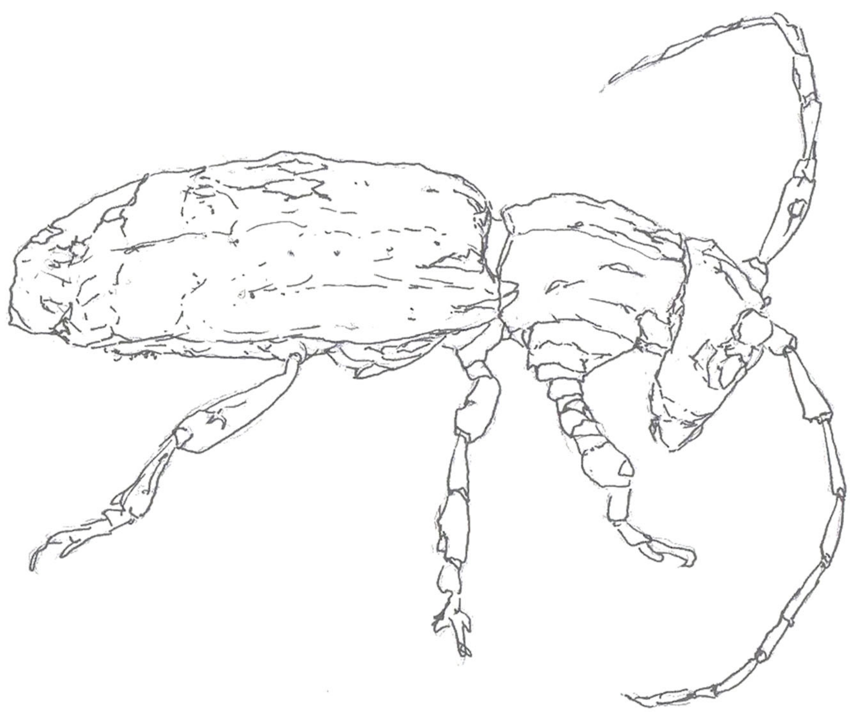
The “Fungus Beetles” include:

- Cisidae—the minute fungus beetles.
- Cryptophagidae—the silken fungus beetles.
- Lathridiidae—minute brown scavenger beetles.
- Tenebriodiae—darkling beetles.
- Cucujidae—flat bark beetles.

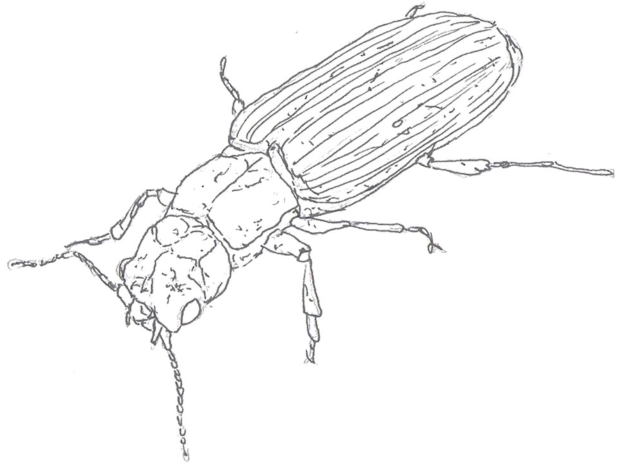
These beetles and their larvae feed on fungus growth on wood, such as Poria, or may be present in damp foods where even tiny amounts of fungus growth or fungal spores are present. The fungus beetles are not wood-damaging pests but are associated with moisture problems and are a good indication that such problems are present.

Many other insects infest and seriously damage wood. Many of these, such as the various bark beetles and round- and flatheaded borers, are found alive most frequently in seasoned wood. The pest management professional is usually most concerned with those insects that damage seasoned lumber. These insects include representatives of the orders Hymenoptera (horntail or wood wasps, carpenter ants and bees) and Coleoptera (beetles). The members of these two orders develop by complete metamorophis, advancing from eggs to larvae, pupae, and adults.

The characteristics of the damage done to wood by these insects are generally sufficient evidence to identify the insects to their family, but positive identification to genus or species requires examination of the insect itself.

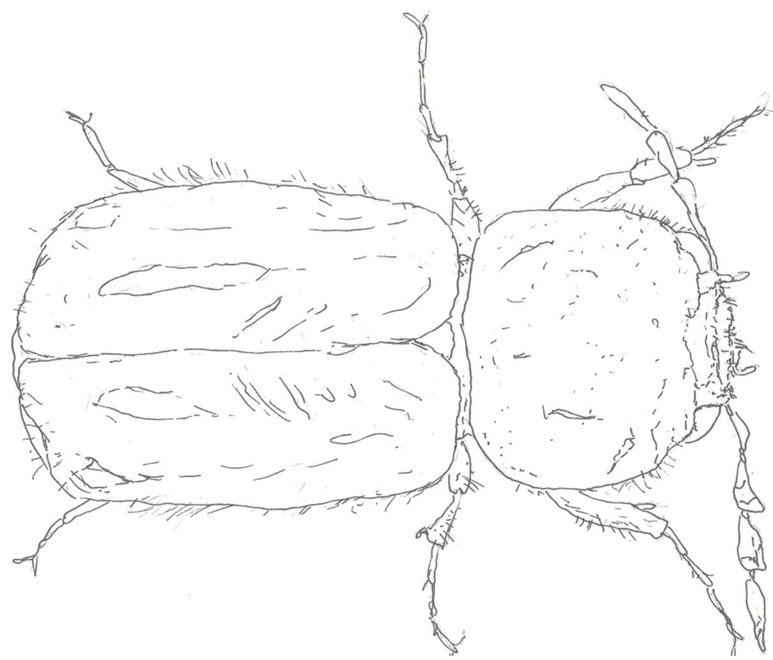


CERAMBYCID POWDERPOST BEETLE (ADULT)

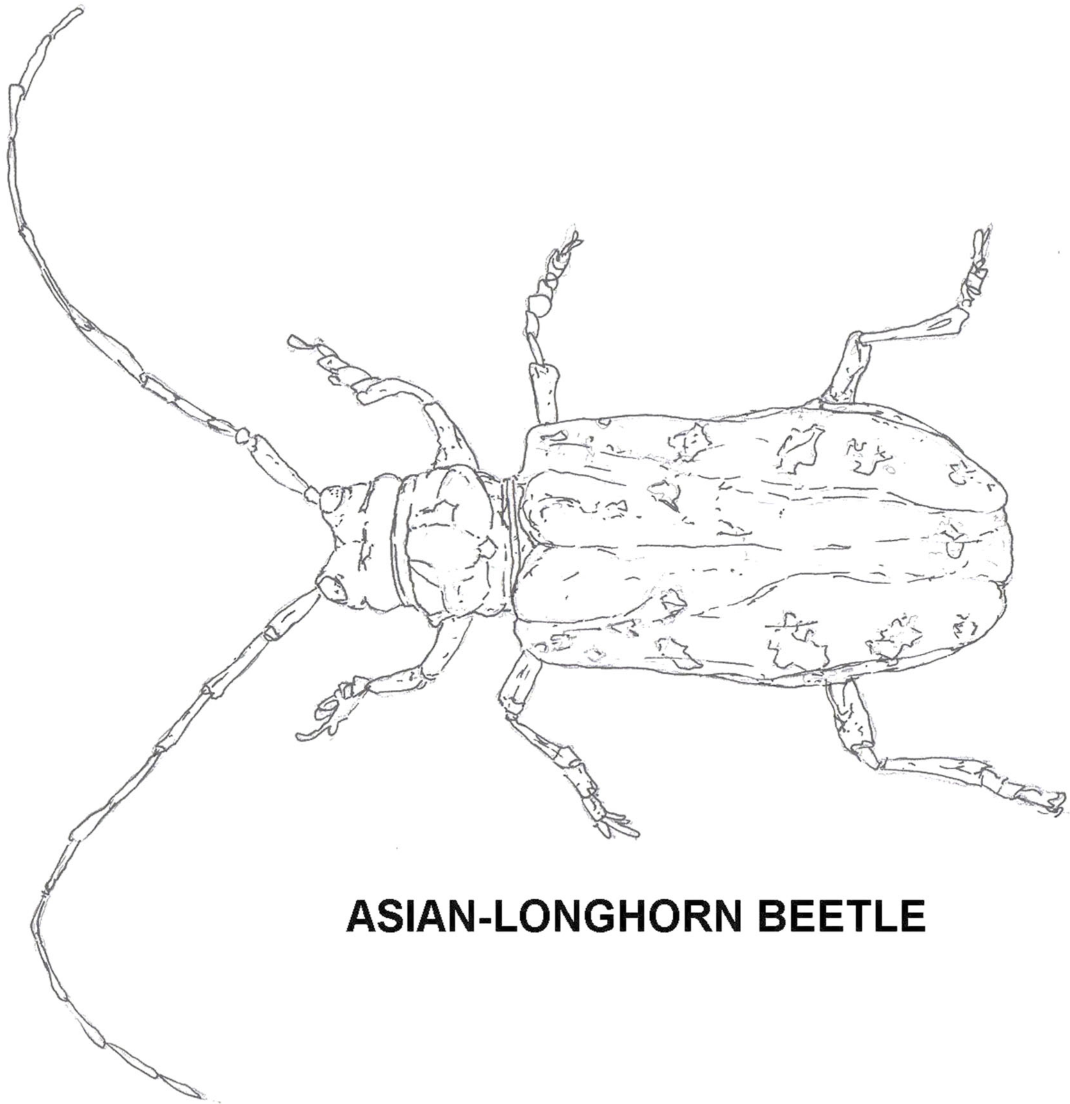


LYCTID POWDERPOST BEETLE (ADULT)

Powder Post Beetles
The term powder post beetle, used in the broad sense, applies to any of the wood-boring species of three closely related families (Lyctidae, Bostrichidae, and Anobiidae) within the superfamily Bostrichoidea. The common name is appropriate because the larvae of these beetles reduce timbers to a mass of very fine, powderlike material. The adults do very little actual damage to wood, serving primarily a reproductive function. There are certain differences in structure, behavior, and nutrition among these groups, and these differences have led to the separation of the families.



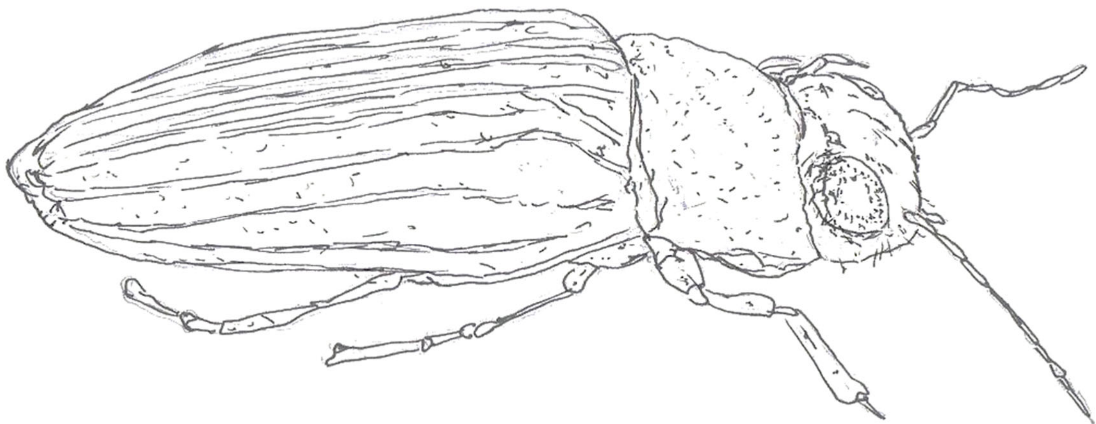
BOSTRICHID POWDERPOST BEETLE



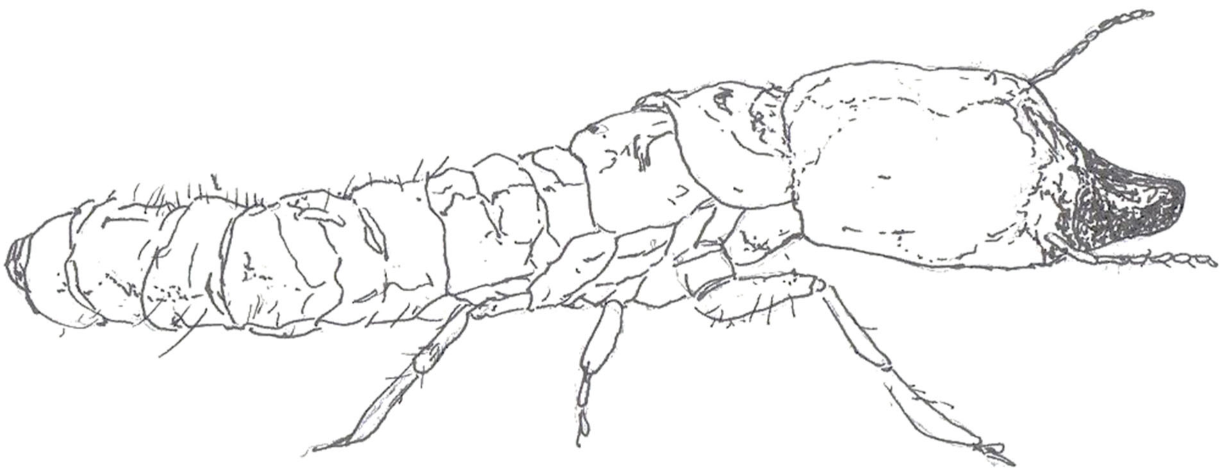
Longhorned Beetles

Longhorned beetles are large (1/2 to 3 inches long), conspicuous beetles with long, thin antennae that may be longer than their bodies. They usually lay their eggs on unseasoned, rough-sawn timbers or logs. The larvae, called roundheaded borers, feed in the wood, boring large, oval-shaped holes as they move through it. Infestation usually takes place before the timber is used in structures. The larvae of some species take more than one year to complete their development, so they may still be feeding in the wood after it becomes part of a structure. Damage is usually limited to pine sapwood and can be recognized by the ripples on the surface of the galleries.

The adult beetle will not lay eggs for re-infestation on this type of wood, so control is rarely called for. However, the exception to this is a species known as the old house borer (Hylotrupes bajulus). Old house borers will attack timbers in a building, so they are the only longhorned beetles requiring control measures. The adult is about 3/4-inch-long and grayish brown to black with two white patches on its wing covers.



BUPRESTID POWDERPOST BEETLE (ADULT)



DRYWOOD TERMITE (SOLDIER)

Bark Beetle Sub-Section *Tree's Enemy*


Cypress Bark Beetle


Ips Knausi


Ips Latidens


Pine engraver


Pinyon Ips


Six spined Ips


Six spined Ips


Southern pine beetle


Turpentine beetle


Turpentine beetle


Western pine beetle


Western pine beetle

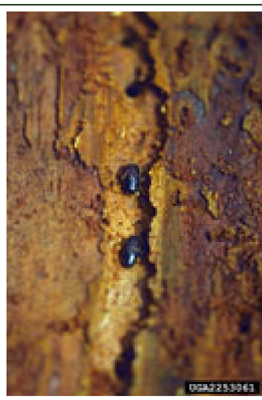
There are many bark beetle genera, of which the most important with respect to forest damage are Dendroctanus, Ips, and Scolytus.

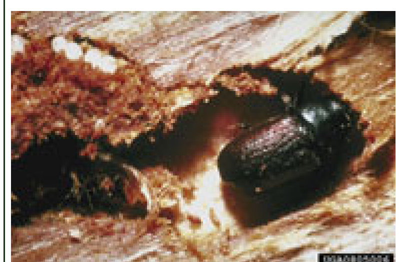
Adult bark beetles bore through the outer bark to the inner cambial layer, where they channel out galleries in which to lay eggs.

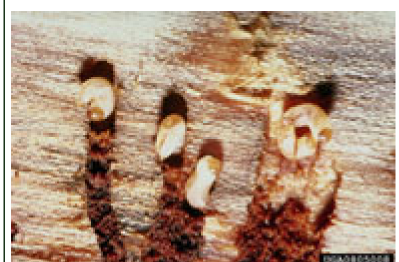

Red turpentine beetle (Galleries)


Red turpentine beetle (Damage - close)

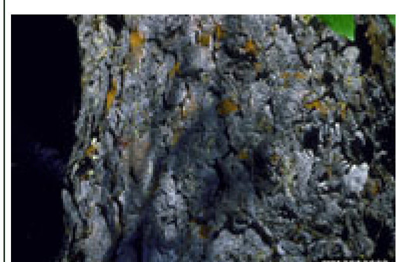

Spruce beetle (Adult)


Spruce beetle (Adult)


Spruce beetle (Eggs)


Spruce beetle (Larva)


Spruce beetle (Galleries)


Spruce beetle (Damage - close)


Spruce beetle (Damage - close)

Pictures Courtesy of the US Forest Service

Pine Bark Beetles

Pine bark beetles are generally of the genus *Ips* or *Dendroctonus*. However, several other genera also attack pine, including: *Hylastes, Hylurgops*, and *Pityogenes*.

Often several species will attack at the same time. Identification of specific beetle species can be difficult. Identification can be aided by knowing the host species attacked, time of year, and the design of the galleries (tunnels) created by the adults and larvae.

Bark beetles contribute to the death of thousands of ponderosa pines each year. Most often when larger trees are attacked and killed they have been weakened by drought, lightning, construction activity or they have been growing on poor sites. Of special concern is the loss of high-value trees at home sites or in developed recreation areas.

Evidence of Infestation

Fading foliage in the tree is often the first sign of a beetle attack. Trees attacked by *Ips* spp. typically fade from the top of the crown downward, while *Dendroctonus* spp. killed trees fade from the bottom of the crown upward. The needles change from green to a light straw color within a few weeks to one year after attack and eventually become brown or red.

Dust caused by boring in the bark crevices and at the tree base is another sign.

Often, numerous small pitch tubes (globules of pitch 1/4 to 1" diameter) appear on the trunk of infested trees. The pitch tubes generally have a creamy appearance, much like crystallized honey.

A pink or red tint may be present in the pitch. The presence of one or two pitch tubes may not mean that a beetle was successful.

Often a few pitch tubes can indicate that the tree successfully repelled the attacking beetle. Clear sap that runs down the bole (trunk) or limbs is generally not from bark beetles.

Life History
Life history varies with each species; the following description is true for most. Beetles become active in April and early May; adults emerge from trees, slash, or firewood infested the previous fall.

Adults prefer freshly cut green trees or trees stressed from drought but when a large number of beetles are present, they attack live pines. ***Ips*** spp. beetles characteristically attack the upper portion of the tree, but when beetles are abundant; the entire tree can be invaded and killed.

Several species will only attack the base of the bole.

Adults bore through the outer bark and then tunnel and lay eggs in the soft inner bark.

Eggs hatch in about a week and larva feed on the inner bark for six to eight weeks before they pupate. It is the boring activity of the adults and larvae that kill trees by girdling in combination with stain fungi the beetles introduce. The development of larvae and pupae of some beetles is completed in the outer bark.

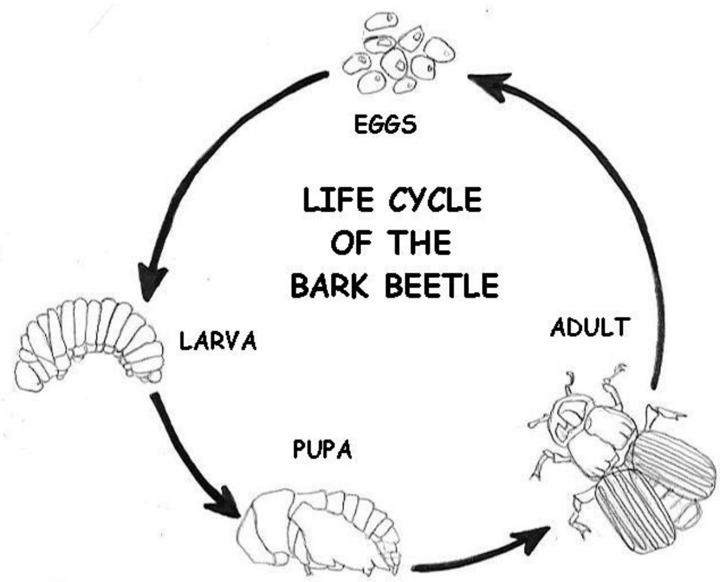
Adults develop from pupae and emerge by boring out through the bark. After emergence, adults fly and attack freshly cut material or susceptible trees and start the next generation. Most beetles produce one to two generations each year but some may have three or four. The overlap of generations during the summer may produce continuous attacks.

Prevention and Control
Freshly cut ponderosa pine slash and firewood are subject to attack by bark beetles.

You can see the evidence of the damage from Bark Beetles; the fire fuel is increased and needs immediate attention and removal.

The success of beetle attacks and production of young beetles are greatly influenced by which season the trees are cut in Trees cut during the late summer and fall are seldom successfully attacked, because the inner bark dries during the fall and winter. The inner bark of green trees cut from January to July remains moist and suitable for beetle habitat.

An exception to this is the roundheaded pine beetle, which flies during the fall, and attacks trees at that time.



Typical bark beetles are (4–6 mm) in length.

The best way to avoid having trees attacked by bark beetles is to take preventive measures. First and foremost, lower tree density through thinning. However, at this time of year thinning may cause increases in bark beetle populations due to the increased exposure of the remaining trees to May and June's drying winds.

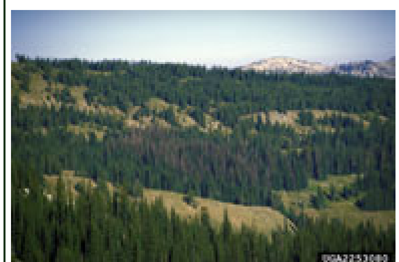
Furthermore, increases in beetle attacks may occur if the newly cut trees are left on the ground for more than 30 days. If the material is hauled off the property to a landfill where the material will be buried or if it is chipped it will not cause a problem. When chipping, don't pile the chips deeper than 3 inches next to live trees, as the chips may attract bark beetles. If it is necessary to create piles deeper than 3 inches, keep the piles in the open sun and as far from live trees as possible. If removal or chipping is not an option, then it may be best to wait until October to begin thinning.

Roundheaded pine beetle activity was found near trees that had been thinned and chipped in October. The slash and limbs of green pine trees should be buried or burned (according to safe conditions and laws) within 30 days after a tree has been cut down. The bole of the tree should receive the same treatment, unless it is needed for firewood or poles. Then the material should be piled away from living pine trees and covered securely to the ground with heavy, clear plastic.

Bark beetles are a common presence on forested land in Arizona. Populations of bark beetle species increase and decrease from year to year. This is a common phenomenon for insect populations. During the summer of 2002, bark beetle populations increased and are creating a problem both for federal and state forested land and for private landowners.

The damage caused by bark beetles is exacerbated by the drought Arizona has suffered for many months. Trees stressed by drought are especially vulnerable to bark beetle attacks. The spruce-fir forests of the Pinaleño Mountains near Safford have suffered severe tree mortality from bark beetle and defoliating insect attacks for the past several years.

Bark beetle attacks have killed large numbers of trees in the spruce-fir forests of the San Francisco Peaks in Arizona. An estimated 100,000 pinion pines are dying in the transition zone east of Flagstaff. Ponderosa pines are suffering severe attacks in the Flagstaff area. Some neighborhoods in Flagstaff have lost nearly 100% of their pines.

 Spruce beetle (Damage - close)	 Spruce beetle (Damage - close)	 Spruce beetle (Damage - far)

BARK BEETLE (ADULT)

Douglas-fir beetle (Adult)

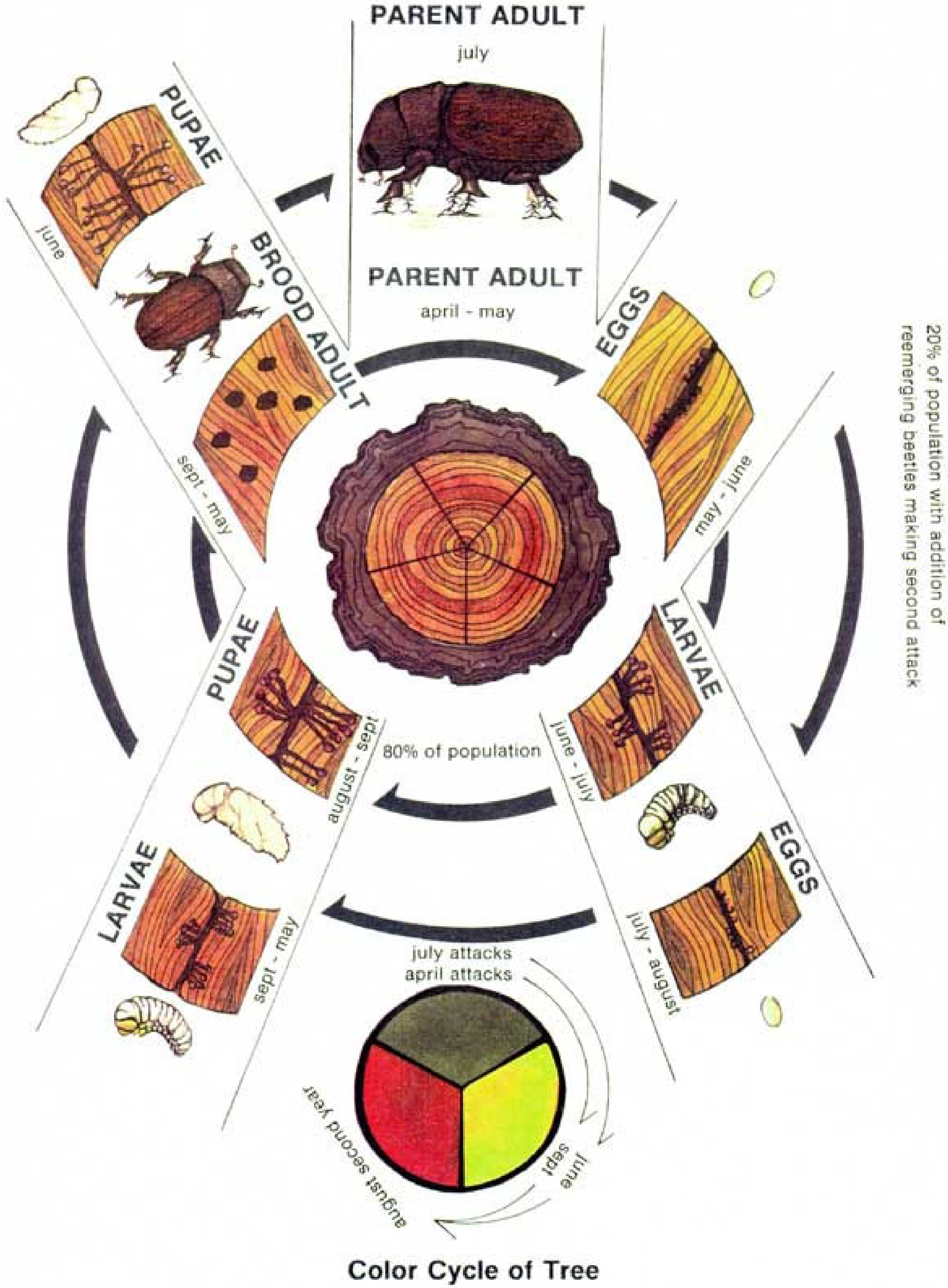
The currently recommended chemicals for this purpose are carbaryl and permethrin. You must use a product that is especially formulated for bark beetles, such as *Sevin SL, Dragnet, Permethrin Plus C*, or *Astro*. This is a protective measure only--it will not kill beetles once they enter the tree. Typical home and garden products containing carbaryl or permethrin will be ineffective. If correct materials are applied properly, protection can be effective for an entire season. Spraying should be completed prior to April 1 to ensure full protection.

If spraying after April 1, you must be sure that the trees have not already been attacked. Trees can be checked for infestations by climbing, with a hydraulic lift, or with high-powered binoculars to inspect the entire trunk of the tree. Also, check the bark crevices and the base of the tree for fresh boring dust. Spraying trees already infested will prove to be ineffective.

The only known direct control method of infested trees is removal. A good rule to remember is "*If the tree is brown cut it down, if in doubt cut it out*." If we leave dead trees standing we run the risk of the new generation of beetles leaving the tree and attacking more trees. Finding reddish-brown boring dust in the bark crevices of a tree indicates that the tree has been successfully attacked, and the tree should be cut down even if the tree is still green at that point. If dead trees are next to houses or other structures, they can become a hazard.

Insecticide injections or systemics have not proven effective against *Dentroctonus* species of bark beetles in studies conducted by U.S. Forest Service and Canadian Forestry Service researchers. Many trees have been injected with what seemed to be success. What may have happened is that the treated tree successfully pitched out the attacking beetle with resin prior to the treatment. The tree was then injected with insecticide when in fact no beetles were actually in the tree. The tree saved itself!

Studies have shown that injecting chemicals will not kill *Dentroctonus* species of bark beetles attacking conifers, and actually injures the tree in the process. We are assuming that chemical injections will be equally ineffective on *Ips* species of bark beetles.



Color Cycle of Tree

Here an applicator is spraying a Pinion Pine for Bark Beetle and Pinion Scale control, these two insects will both attack and destroy a tree this size within 12-16-month period. This period will depend upon rain and weather conditions.

You have a 40% chance of saving a tree as this one if the spraying is done within 3 months of infestation and spraying again on an annual basis. But, everything depends upon the weather. If it is dry, the tree has a greater chance of ending up in the fireplace.

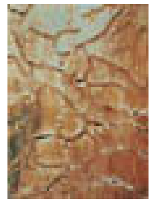
Bark beetles are also expected to kill most of Colorado's lodgepole pine trees.

A pesticide applicator is examining bark beetle damage in a dead pine tree. The bark beetles had a protective layer of bark approximately 2 inches thick. It would have been nearly imposable to apply enough chemical to penetrate this hard bark exterior.

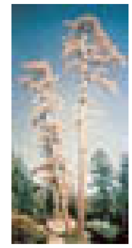
Bark beetles have a hard protective head and are very strong. These insects almost bite you if you were to place them in your hand. They are like tiny bulldozers and will work hard to get out of your hand and into a fresh tree. I am truly impressed with their destruction efforts.

Western Pine Beetle, *Dendroctonus brevicomis,*

Larvae.



Egg and larval galleries are usually packed with dust.



Killed ponderosa pine.

Tree Species Attacked: Mature to old ponderosa pine trees are attacked.

Insect Description & Damage Symptoms: One to two generations of beetles are produced every year, depending upon the elevation. Adults are brown to black, cylindrical, stout-bodied, hard-shelled, and about 3 to 5 mm long. They construct long, meandering, dust-packed galleries in the cambium of attacked trees. During periods of heavy attack, the galleries may cross and re-cross, forming a complex network.

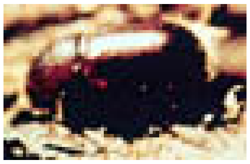
The timing of western pine beetle attacks depends upon elevation; they can occur any time from May to September.

Reddish-brown boring dust will be present at the base of attacked trees. Inconspicuous reddish-brown pitch tubes can sometimes be found in bark crevices. Needles will pale and then fade to yellow, to reddish-brown, and finally to red in the months following the attack. Flaking of the bark by woodpeckers in search of beetles or larvae is also a symptom of infestation.

Damage: Usually, the western pine beetle breeds in scattered, old, slow-growing, or diseased trees; and trees weakened by stand stagnation, lightning, fire, or mechanical injury. This beetle, however, will also attack and kill healthy young trees during an epidemic, although trees under 15 cm in diameter are seldom attacked. Attacking adults also carry the spores of a blue stain fungus that can invade and block, along with feeding larvae, the conductive vessels of the inner bark and sapwood.

Similar Damage: May be confused with the mountain pine beetle or secondary beetles. The conspicuous serpentine galleries distinguish the western pine beetle.

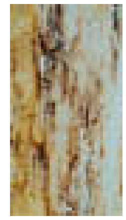
Western Balsam Bark Beetle, *Dryocoetes confusus*



Adult.

Larva.

Attacked trees. Note: this color usually appears within a year following an attack.



Egg and larval galleries.

Tree Species Attacked: Primarily sub-alpine fir is attacked, but occasionally, amabilis fir. Some attacks of white spruce and Engelmann spruce have been recorded. Mature trees are targeted.

Insect Description & Damage Symptoms: Adults are 3.4 to 4.3 mm long, dark brown, and covered with erect, red-brown hairs. They emerge in late May or June. The life cycle normally requires two years, but given the right climatic conditions, it could be completed in one year. The extent of an infestation is difficult to determine as a result of overlapping life cycles, a lack of telltale pitch tubes, and the fact that the majority of the attacks occur above 2 m on the bole. The adults construct egg galleries that have a central nuptial chamber with brood galleries radiating from the top and bottom. A mixture of boring dust and frass is usually found in bark fissures and at the base of the bole. The foliage of an attacked tree will change from green to a bright, brick-red color in the year following the attack, but the red needles may be retained for up to five years.

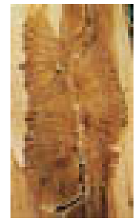
Damage: Given the appropriate conditions, balsam bark beetles can be responsible for extensive tree mortality in stands containing a large percentage of the preferred host.

Normally, however, less than 5% of a stand is attacked in a single season, with the damage usually scattered throughout the stand. The adult carries a lesion-causing fungus, *Ceratocystis dryocoetidis,* which is responsible for an estimated 65% of the mortality associated with balsam bark beetles. The lesions caused by the fungus may girdle and kill a tree, and they also make the tree susceptible to further beetle attacks.

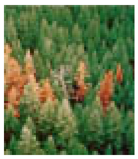
Douglas-fir Beetle, *Dendroctonus pseudotsugae*

Larva in gallery.

Adult Douglas-fir beetle.



Egg and larval galleries are about 30 cm in length and packed with frass.



Attacked trees. Note: red color usually appears by the spring of the year following an attack.

Boring dust can be found in crevices at the base of the tree.

Distribution: Throughout most of the range of its principal host. Damage is usually most intensive in the interior of forest.

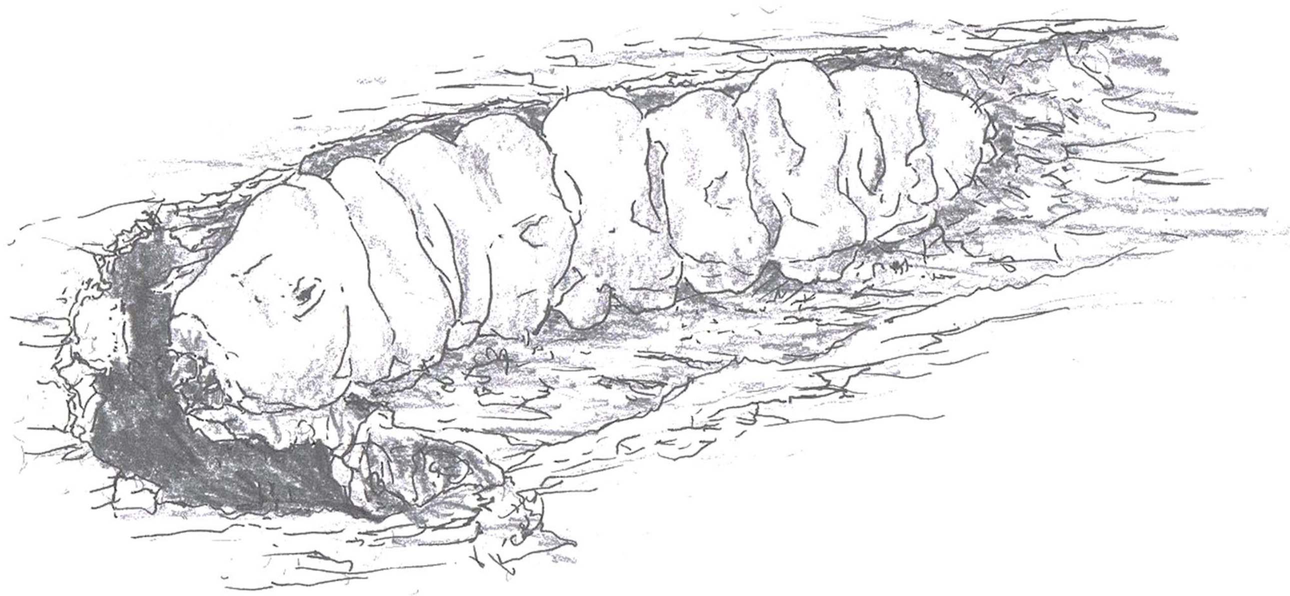
Tree Species Attacked: Large-diameter, mature Douglas-fir trees are attacked, and occasionally, downed western larch.

Insect Description & Damage Symptoms: Adults are dark brown to black with reddish wing covers and about 4.4 to 7 mm long. The usual life cycle is one year, but two broods may be produced. The main flight period usually occurs in May and June, while a second flight in July and August may be made by adults developed from overwintering larvae or adults re-emerging after the earlier flight.

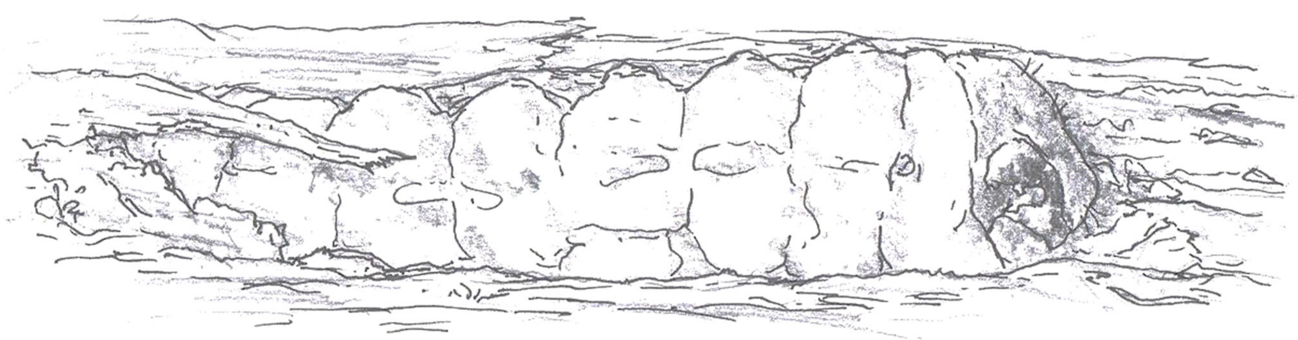
Adults lay their eggs in long galleries constructed parallel to the grain of inner bark. Reddish boring dust may be found in bark crevices or at the base of the tree. Adult beetles will often not attack the bottom portion of the bole, making identification difficult. Pitch tubes are not formed, but the tree may exude resin from upper attacks. Foliage of killed trees turns from green to pale yellow-green to red by the spring of the year following the attack. Red needles may remain on the tree for up to two years after an attack and aerial spotting of these "***redtops***" helps to determine the extent of an outbreak. Sometimes needles will drop without any discoloration.

Damage: Douglas-fir beetles normally infest felled trees, mature damaged trees, logging debris, and trees stressed by drought. When sufficient host material is unavailable, however, they will attack and kill vigorous trees, causing more extensive damage. Trees are killed when the flow of food and water between the roots and needles is blocked by feeding larvae and by dead sapwood cells killed by the blue-stain fungi carried by the Douglas-fir beetle adults. On the coast, it often takes two years of attack to kill a tree (partial or "***strip***" attack occurs the first year).

Similar Damage: Attacks by secondary bark beetles may produce boring dust in bark crevices. The Douglas-fir pole beetle is usually found in the smaller diameter, upper portion of the stem. It can be distinguished from the Douglas-fir beetle by its finer boring dust and different gallery patterns.



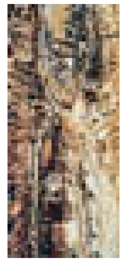
POPLAR BORER LARVAE AND DAMAGE



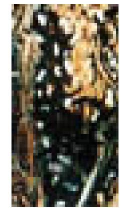
LOCUST BORER LARVAE AND DAMAGE

Ips Beetle, *Ips spp.,*

Adult. Note: rear concave depression lined with spines



Egg and larval galleries. Larval galleries radiate from the central nuptial chamber. No frass is present.



Larvae brood in a lodgepole pine tree. Ips galleries tend to contain multiple generations.

Tree Species Attacked: The most critical attacks occur in pole-size to mature lodgepole pine, ponderosa pine, and western white pine.

Insect Description & Damage Symptoms: Adults are reddish-brown to black, often shiny, cylindrical, and about 3 to 6 mm long. An easily recognizable feature of the adult is a pronounced concave depression at its rear end, which is lined on each side with up to six tooth-like spines. The head is not visible when viewed from above.

Adults emerge and begin their attack from mid-May to early June. Pitch tubes are rarely formed or are very small, but fine yellow-red boring dust is usually found in bark crevices. Attack usually advances from the top downward on standing trees.

A change in the foliage color from dark to faded green is usually the first obvious symptom, but the best way to determine if a tree has been attacked by Ips is to remove a piece of bark and examine the tree for evidence of egg galleries. Ips egg gallery patterns consist of a central nuptial chamber from which two or more egg galleries radiate.

Larval galleries extend at right angles to the egg galleries and often score the surface of the sapwood, a characteristic that causes some to call the Ips "*engraver beetles*". The galleries are free of boring dust and frass.

As the tree or top portion of the tree dies, color change continues to yellowish-red and then a dull brick red. Two to three generations of beetles may be produced per year; therefore, engraver beetle populations can expand rapidly.

Damage: Ips beetles usually only attack dead, dying, or damaged trees. They are also often found in the upper portions and on the south sides of trees attacked by the mountain pine beetle, and in conjunction with black-stain fungus. However, heavy populations can build up in windthrow and slash, which can pose a threat to healthy green trees. Ips damage often occurs at the edges of cut blocks.

Similar Damage: May be confused with mountain pine beetle or other secondary beetles. Ips beetles can be distinguished by the gallery patterns and the distinct shape of the adult.

Fir Engraver Beetle, *Scolytus ventralis*

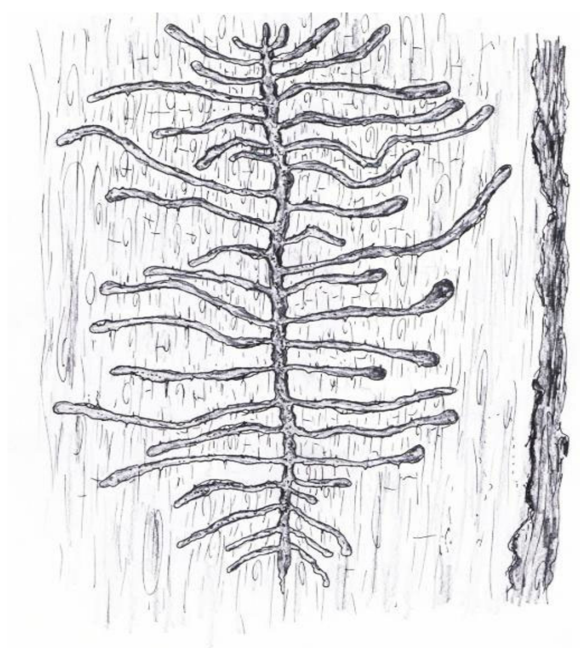
Tree Species Attacked: The primary hosts are true firs, though occasionally Douglas-fir and spruce are infected. Trees from pole-size to mature are susceptible.

Insect Description & Damage Symptoms: The adult beetles are shiny, black to reddish-brown, and about 4 mm long. A side view shows that the end of an adult's abdomen is incurved.

The beetles bore into the inner bark of trees from June through September, leaving reddish-brown boring dust on the outer bark. The beetles introduce a brown-stain fungus to the sapwood. The galleries the beetles form are very distinctive, in that the egg gallery is constructed horizontally across the grain of the wood for a distance of 5 to 15 cm on both sides of a central entrance chamber. These galleries are deeply scored into the wood. When they hatch, the larvae mine up and down the bole for distances of 13 to 18 cm. The life cycle of the fir engraver beetle is usually completed in one year, though in colder, upper elevations it may take up to two years to complete.

Damage: Trees are often top-killed, can be killed outright if attacked by enough beetles, or may survive repeated attacks for many years. Trees that survive may only be attacked in patches on the bole. Within a patch attack, the cambium is killed and a brown pitch pocket is formed in the wood. These partial attacks are seen externally as roughened patches of bark or scattered dead branches that have been girdled by egg galleries. Trees that are weakened by drought or root disease are particularly susceptible to attack. Populations can build up in slash or windthrow before attacks are made on living trees.

Similar Damage: May be confused with other bark beetles initially, but the distinct gallery pattern and the deep scoring of the wood differentiates the fir engraver beetle.



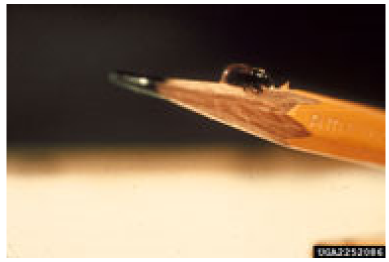
BARK BEETLE TRAILS (DAMAGE)

The pinion needle scale can be controlled on selected trees by spraying a dimethoate-water emulsion (3 gals. of a 30.5 percent emusifiable concentrate per 100 gallons water, approximately 1 percent) to egg masses at the base of the trees and to all bark and crotches that can be reached from the ground.

Make this bark application when crawlers, start to emerge from the eggs. Crawlers emerge about 7 to 10 days after red eye spots become visible in the eggs under a hand lens, normally in early June in northern Arizona - New Mexico and southwestern Colorado. Timing the spray application is critical for effective control. Use hydraulic or back-pack sprayer. Do not spray needles since phytotoxicity may result: Do not apply to pine trees used for pine nut or pinion nut production.

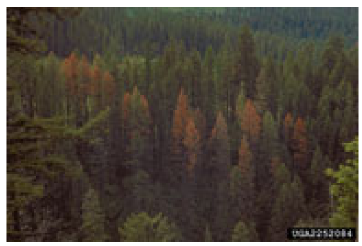
Preventative Spraying for Ips and Western Pine Beetles


Douglas-fir beetle (Adult)


Douglas-fir beetle (Adult)


Douglas-fir beetle (Galleries)


Douglas-fir beetle (Damage - close)


Douglas-fir beetle (Damage - far)


Mountain pine beetle (Adult)

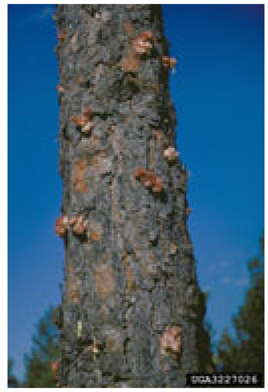

Mountain pine beetle (Adult)


Mountain pine beetle (Larva)


Mountain pine beetle (Pupa)

The western pine beetle WPB and Ips species are insects capable of attacking and killing ponderosa pine and pinion pine. Periodic epidemics are capable of causing heavy mortality in drought stressed and dense stands of pine. Many situations exist where high-value pines require protection from uncontrolled beetle pressures nearby.


Mountain pine beetle (Galleries)


Mountain pine beetle (Damage - close)


Mountain pine beetle (Damage - close)


Mountain pine beetle (Damage - far)


Mountain pine beetle (Damage - far)


Pine engraver (Adult)


Pine engraver (Galleries)


Pine engraver (Damage - far)

Red turpentine beetle (Adult

Pictures Courtesy of the US Forest Service

Pinyon Needle Scale

Pinyon needle scales, known by their scientific name, (*Matsucoccus acalyptus*), are .5mm in size. Wingless females emerge from scale coverings on the bark of the tree in April to mate with male insects that have wintered in webs beneath the trees.

After mating, the female lays visible eggs. Four to five-and-a-half weeks later, the nymphs hatch and crawl to the tree's upper foliage to feed. Once they start to eat, they cover their bodies with a waxy coating that safeguards them against the environment, predators and contact insecticides.

The pinyon needle scale defoliates juvenile pinyon pine (*Pinus edulis*), while the stem-boring moth (*Dioryctria albovittella*) kills shoots of mature trees. The impact of these herbivores is regionally extensive, encompassing pinyon woodlands on a variety of substrates, and appears to be positively correlated with abiotic stress.

Studies demonstrate that scale and moth herbivory chronically reduce stem growth and reproduction, alter tree architecture and soil microclimate, decrease mycorrhizal mutualists, and increase litter quality. In all major functional groups of organisms examined to date (i.e., soil bacteria and fungi, litter and canopy arthropods, and birds and mammals), we have found fundamental differences in abundance and/or composition between high- and low-herbivory trees and sites. Thus, it is clear that tree performance, community structure and biodiversity are dramatically altered by chronic herbivory in this ecosystem. We do not know, however, to what extent basic ecosystem functions are also affected.

Taking advantage of two long-term moth and scale removal experiments, (15 and 13 years, respectively), we propose to examine the ecosystem effects of herbivory in experimental plots centered on three classes of trees, **1)** Trees infested with moth or scale insects, **2)** Susceptible trees from which these herbivores have been removed annually for at least 13 years ("defaunated" trees), and **3)** moth or scale resistant trees. We emphasize that our uniquely long-term defaunation treatments allow us to compare *experimentally* the ecosystem consequences of chronic invertebrate herbivory, consequences that may require long periods to develop.

We propose four hypotheses concerning ecosystem responses to chronic herbivory:

1) Herbivory reduces net primary productivity (NPP) overall, but particularly belowground, such that the ratio of aboveground-belowground NPP increases.
2) Reduced soil C inputs due to herbivory increase microbial C limitation, reduce N immobilization and enhance net N mineralization.
3) Herbivory increases litter nutrient quality by preventing translocation prior to litterfall, which will increase nutrient loss via leaching due to reduced belowground NPP.
4) By significantly altering tree architecture, the two herbivores will have significant but opposite indirect impacts on litter decomposition and nutrient cycling by changing soil temperature and water regimes.

Testing of these hypotheses and related predictions is crucial to understanding the roles of major herbivores on populations, communities, and ecosystems.

"Removal of the eggs from your pinyons will be simplified if you have already treated your vegetation for fire prevention (by thinning and pruning)," Celaya said. "If you have pinyons infected with needle scale, you can basically walk right up to the tree and see the egg masses. Of course, if you haven't pruned, it will be hard to get to the egg masses on those trees."

Ways to Detect Scale-infested Pinyons
• Clusters of yellow eggs held together in loose, white, cottony webbing in branch crotches, the underside of large branches and the base of the trunk.
• Yellow-orange discoloration of needles toward the back of the branch.
• Needles covered with small, black, bean-shaped scales.
Control of the scale at this egg stage of the insect is a three-part process. First, wash the eggs off branches and trunk with a garden hose, equipped with a high-pressure nozzle, then allow the eggs on the ground one or two days to dry. Next, rake the eggs out from under the tree. Then, dispose of the eggs in plastic garbage bags.

MAGNIFIED VIEW OF A TERMITE

Proven Methods (Prevention)

Preventive spraying provides a proven method of keeping uninfested but susceptible pines alive, despite attempted attack. As such, it is relatively safe and affordable "***insurance***" that protects key trees until the nearby beetle threat subsides.

CANDIDATE TREES – In the great majority of cases, trees selected are big, valuable ponderosa and pinion pines. Of course, trees selected should be species normally attacked by either the western pine beetle or ips beetle. If these are the insects of concern, then spruce, fir, and juniper do not need to be treated. (Note, these species are attacked by other bark beetles and may warrant preventive spraying when their respective threats are present.)

Preventive spraying involves the application of pesticides and is usually performed by commercial applicators. Because of the associated environmental considerations and expense, it is neither practical nor advisable to spray every tree on a tract of land. Rather, preventive spraying is intended for important, "***must-save***" high value trees.

Since WPB and ips rarely attack trees under 4 inches in diameter, smaller trees do not normally require spraying. These beetles attack stressed trees more often than healthy ones. Stress factors include: mistletoe, root cutting, bark wounding, soil compaction, drainage changes, adverse weather (such as drought), and infestation by other insects. A tree's value is subjective, but typically comes from its size, pleasing shape, shade and proximity to recreation sites and homes.

Home builders should remember that trees carefully saved during construction were probably stressed, and as such, are attractive to beetles. Other highly vulnerable trees are those with infested firewood stacked against them and those near infested trees from which the WPB and Ips will fly.

WHEN TO SPRAY – Based on the tested residual of materials registered for preventive bark beetle spraying, treatment needs to be done before beetle flight in **March or April on an annual basis during years when the risk of beetles is high.**

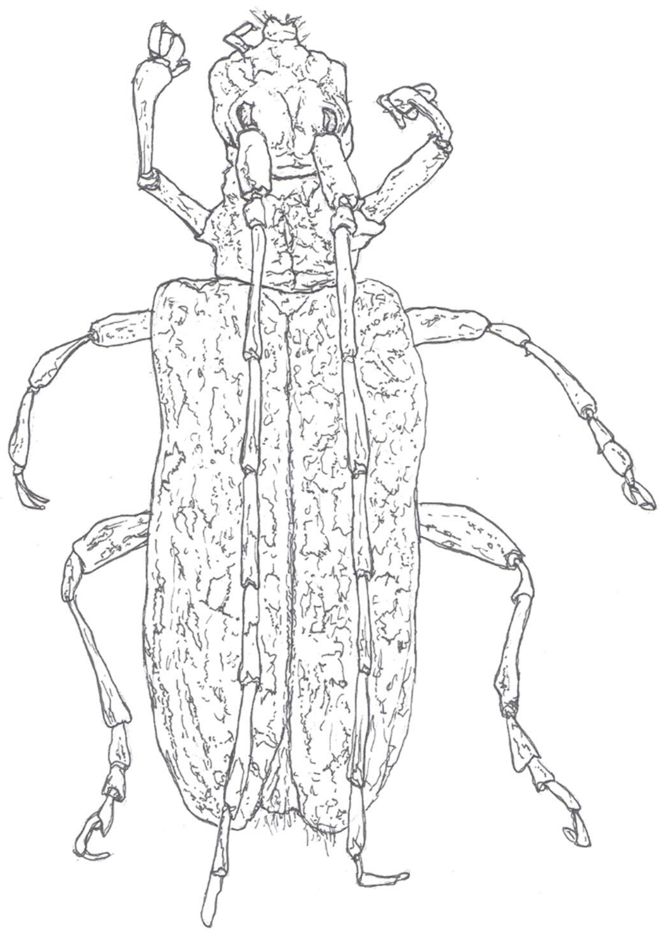
Infestations can last a number of years in a local area and are often dependent on host availability and weather conditions. High precipitation years will help the pine produce sap needed to fend off beetle attacks.

CHEMICALS LABELED FOR PREVENTIVE SPRAYING - Over the past 20 years, the standard for bark beetle preventive spraying has been **carbaryl (trade name Sevin)** This carbamate has long been used for the control of leaf-chewing insects in both forest and garden situations. Carbaryl comes in many formulations.

The liquid concentrates designed for use on large trees require dilution with water prior to application. Never dilute with petroleum liquids such as diesel fuel. Carbaryl is most effective when the pH of water used for dilution is 6 (slightly more acidic than neutral). When using water of pH 7 to 8, it may be advisable to add household vinegar to the spray mixture to achieve a pH of 6. (A pint of vinegar is enough to lower the pH of 25 gallons of spray about 1 point).

ALWAYS READ THE LABEL FOR COMPLETE MIXING INSTRUCTIONS AND SAFETY PRECAUTIONS.

Since about 1995, a second material called permethrin (trade names Astro, Dragnet and others) has been used for bark beetle prevention. This synthetic permethrin performed very well as a preventive bark beetle spray in research tests in California, Montana, and the South.



PINE SAWYER BEETLE (ADULT)

Bark Beetle Post Quiz
Identity the Insect

1. Carpenter worms are large caterpillars that grow to almost three inches long. They mine the heart wood of trees. They attack poplars and cottonwoods and can attack many other trees as well.

2. The adult carpenter worm is a large grey moth.

3. Poplar borers are a serious pest of poplar. Adults emerge and are around from June through August.

4. Most of the life cycle is spent as the larva in the tree. They feed for a period of 2-4 years and bore in the heartwood and sapwood. Infested trees can be weakened and break. A related species causes galls on smaller limbs of poplars and aspens.

5. Many clear-winged moths bore in trees as larvae. The adults resemble wasps in many cases.

6. The larvae are legless grubs that feed just under the bark. Enough larvae can girdle a tree. In affected trees, the tops turn red then yellow and brown. Different species can be determined by the shape of the gallery in some cases.

7. Shot hole borers attack weakened or dead trees and shrubs. They feed deeper in the wood than bark beetles. The larvae are legless grubs. Many emergence holes are often present where several adults have emerged. Thus, the "***shot hole***" appearance on affected trees.

8. The peach twig borer is a pest because it mines in the ends of the new twigs of fruit trees and ornamental fruit trees. The new twigs start to grow and then wilt because these larvae are tunneling down the center of them. Adults are small grey moths.

9. The caterpillars of clear-winged moths can extensively mine limbs of susceptible trees. Poplars, willow, and cottonwood trees are hosts of several species.

10. Although not true borers, bark beetles attack several evergreen trees. The adults usually emerge in mid-summer and lay eggs.

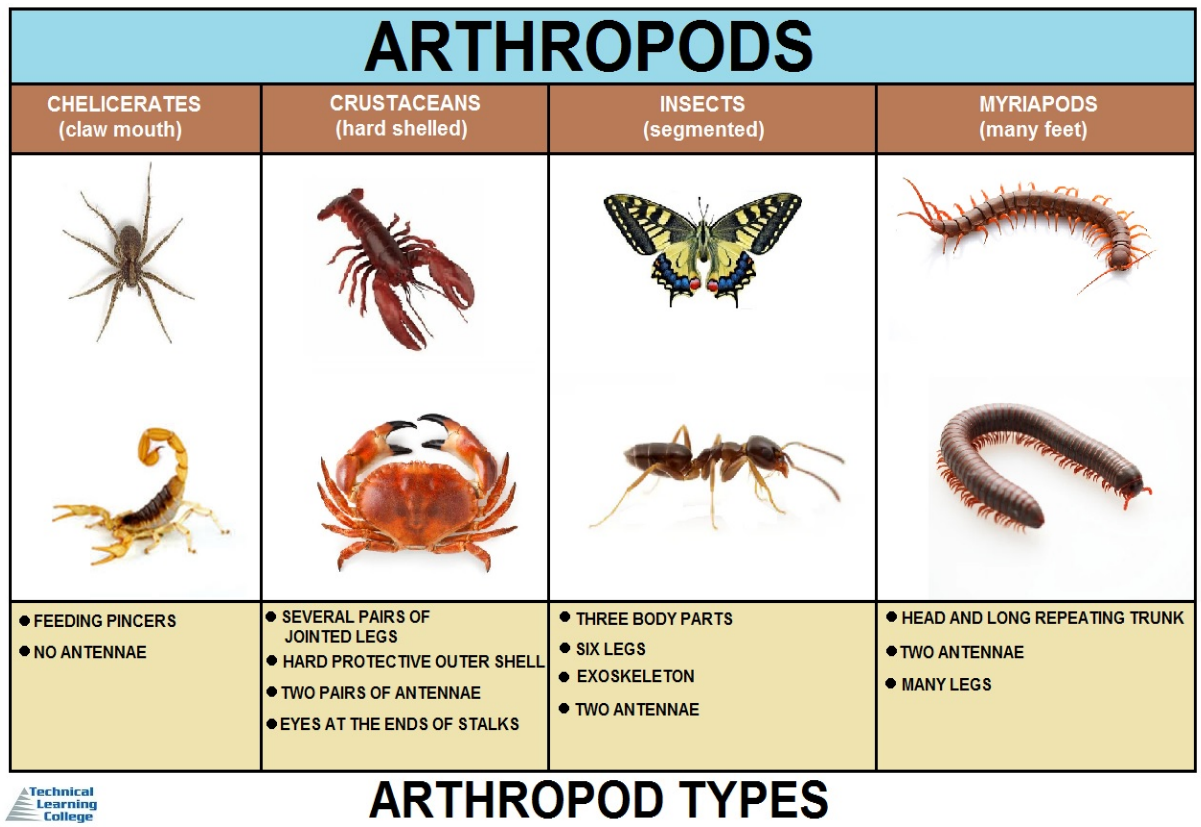
Answers

1. Carpenter worm larva, 2. Carpenter worm adult, 3. Poplar borer adult, 4. Poplar borer larva, 5. Clear-winged moth adult, 6. Bark beetle larvae, 7. Shot-hole borer adult, 8. Peach twig borer larva, 9. Clear-winged moth larva, 10. Bark beetle adult

Topic 9- Arachnid Introduction

Section Focus: You will learn the basics of the arthropods, focusing on the arachnid order. At the end of this section, you will be able to understand and describe the arachnids. You will learn about the Arachnid family class, genera, life cycle and related subjects. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: There are eleven orders of arachnids. These include the scorpions; mites and ticks; harvestmen; pseudoscorpions; whipscorpions; solpugids; and spiders. It's like the relation of beetles with insects: beetles constitute one order of insects, the Coleoptera, but not all insects are beetles. Similarly, not all arachnids are spiders.



Class Arachnida

The class Arachnida is the most familiar of the arthropods outside of the ever-present insects. There are over 80,000 named species, and they are united by the possession of eight legs, chelicerae, and pedipalps, and the lack of biting and chewing mouthparts (food is ingested in most cases as a liquid, though some help is often given the food in becoming liquid by the secretion of, or regurgitating onto or into the food of, digestive enzymes from the stomach.

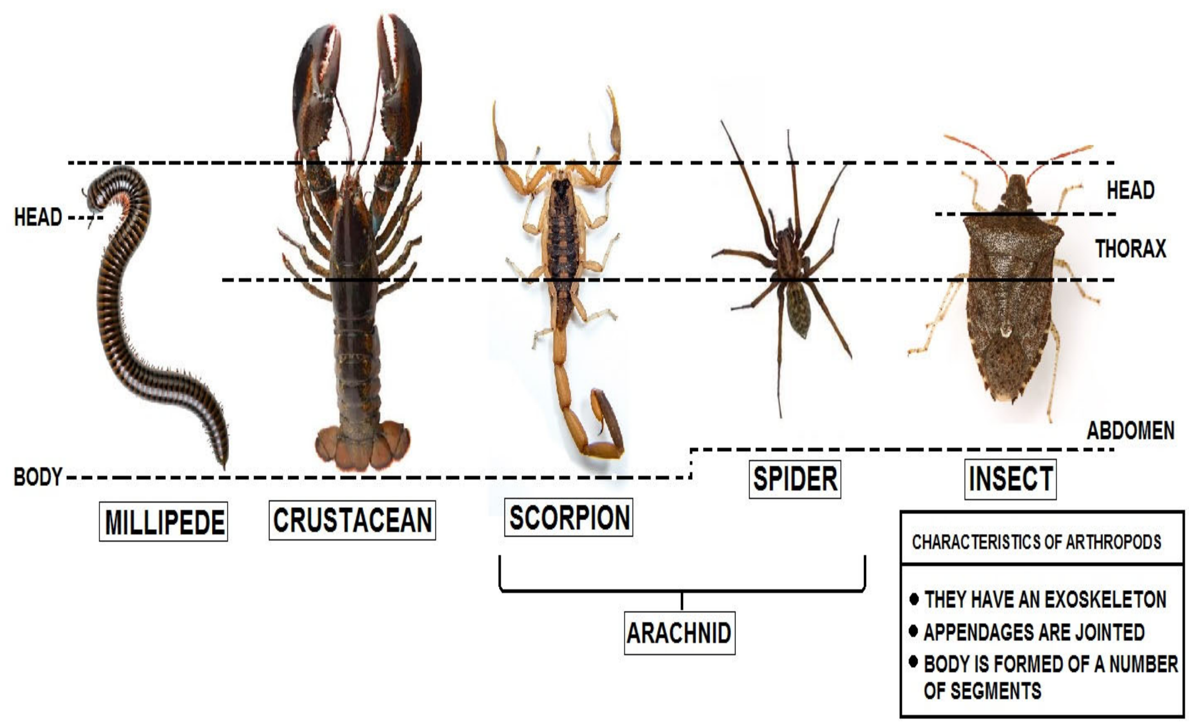
The arachnids are thought to have evolved in the sea, but now they are almost entirely terrestrial and have developed several important features to help them survive on the land. These include: a waterproof (waxy) exocuticle, internal fertilization, malphagian tubules as a metabolic excretory system, and internal organs for breathing and gaseous exchange.

The class Arachnida is extremely diverse in form and in lifestyles, and little more can be said that includes them all. This diversity is reflected in the following classification scheme.

Arachnida Classes

The class Arachnida is divided into 13 subclasses, (or orders, depending on which classification scheme you are following), of which the Araneae (spiders) and the Scorpiones (scorpions) are the best known.

- Subclass Scorpiones (Scorpions)
- Subclass Pseudoscorpiones (Pseudoscorpions)
- Subclass Solifugae (Sun Spiders or Wind Scorpions)
- Subclass Palpigradi (Miniature Whip Scorpions)
- Subclass Uropygi (Whip Scorpions)
- Subclass Schizomida
- Subclass Amblypygi (Whip Spiders)
- Subclass Araneae (Spiders)
- Subclass Ricinulei
- Subclass Opiliones (Harvestmen)
- Subclass Acari (Mites) Acariformes, Notostigmata, and Parastiformes



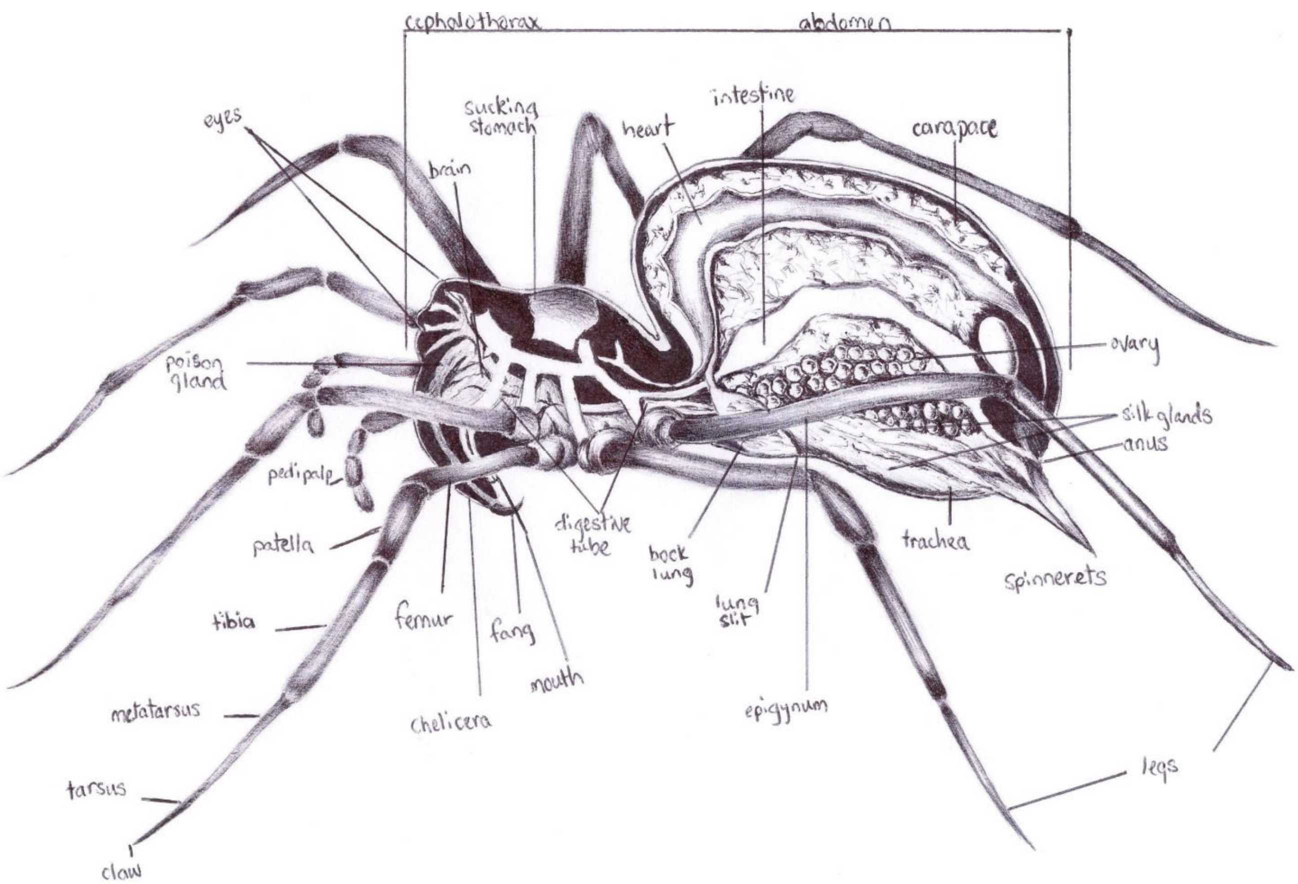
CHARACTERISTICS OF ARTHROPODS

Spider Introduction

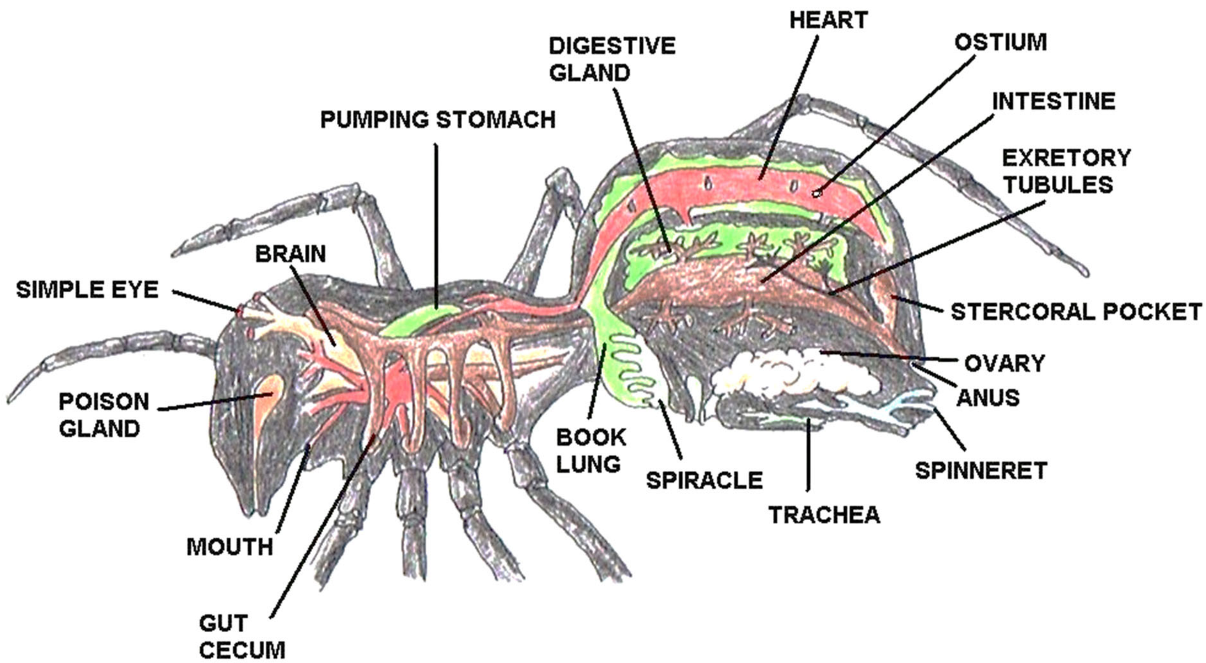
Spiders are mostly terrestrial, of the class Arachnida, order Araneae, with four pairs of legs and a two-part body consisting of a cephalothorax, or prosoma, and an unsegmented abdomen, or opisthosoma. The cephalothorax is covered by a shield, or carapace, and bears eight simple eyes.

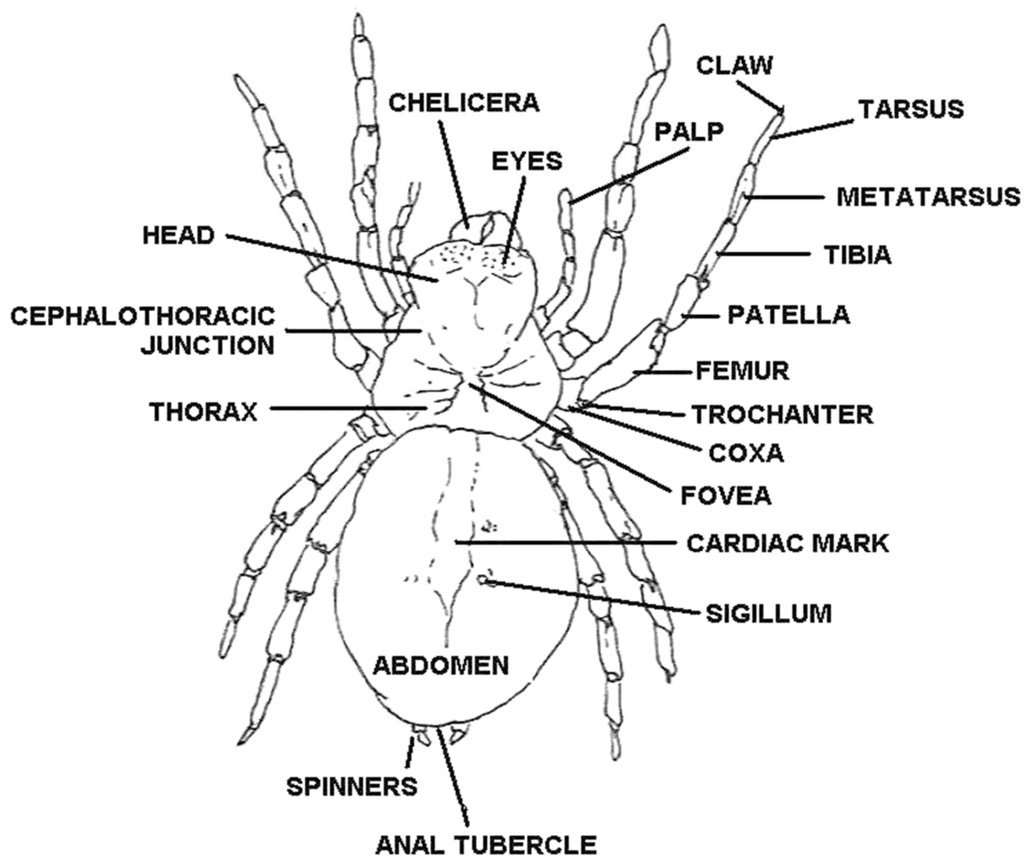
On the underside of the head (the cephalic part of the cephalothorax) are two pairs of appendages, the anterior pair called chelicerae, and the second pair pedipalps, with which the spider captures and paralyzes its prey, injecting into it venom produced in the poison glands. The spider then liquefies the tissues of the prey with a digestive fluid and sucks this broth into its stomach, where it may be stored in a digestive gland. Breathing is by means of tracheae (air tubes) or book lungs, or both.

Arachnid book lungs are similar to the gill books of horseshoe crabs, but are internal and adapted to a terrestrial habitat. Three pairs of spinnerets toward the tip of the abdomen produce protein-containing fluids that harden as they are drawn out to form silk threads. Several kinds of silk glands and spinnerets produce different kinds of silk used variously for constructing cocoons or egg sacs, spinning webs, and binding prey; other light strands are spun out for ballooning, or floating, the spiders, especially young ones, long distances on air currents.

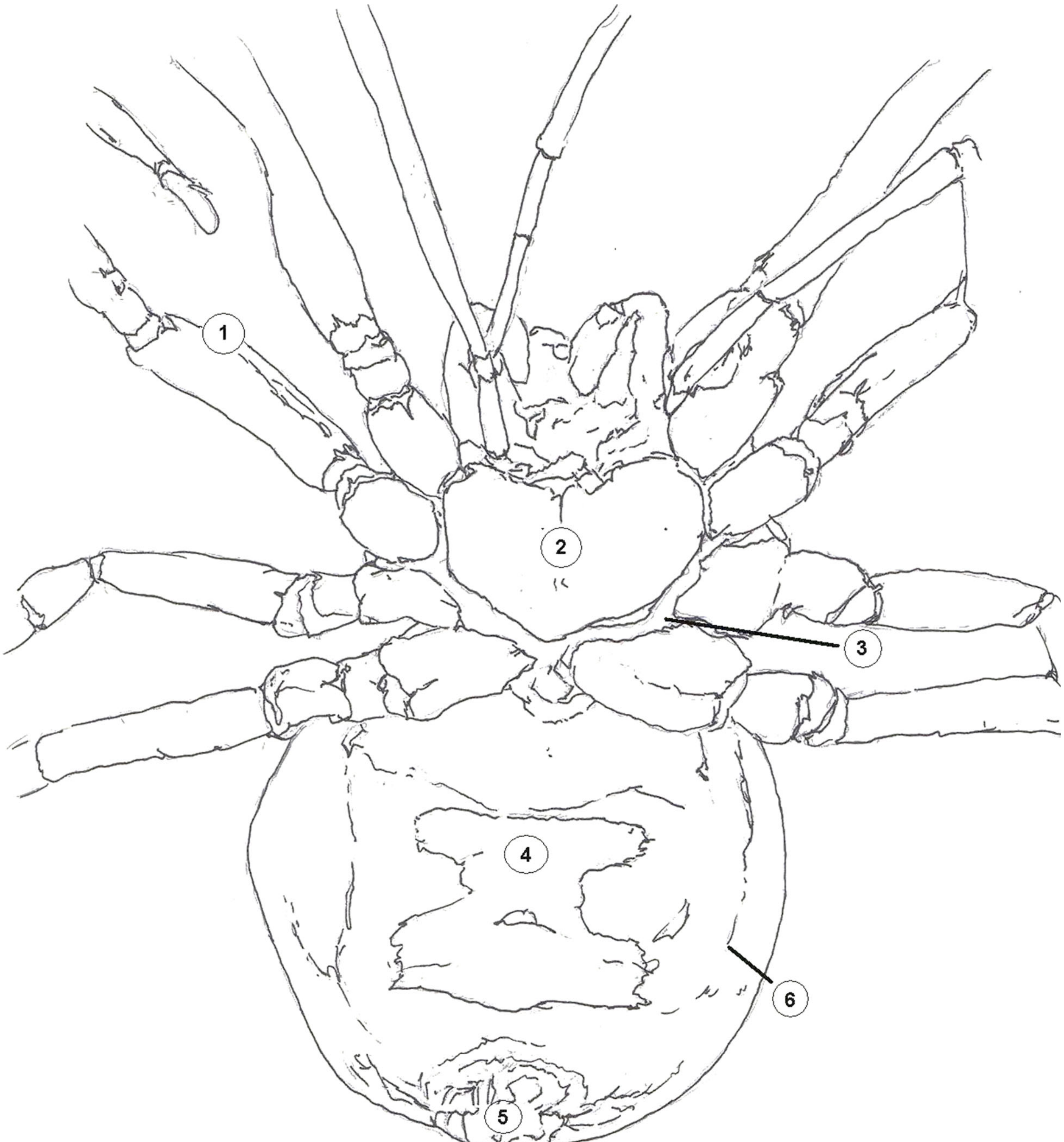


SPIDER ANATOMY DIAGRAM #1





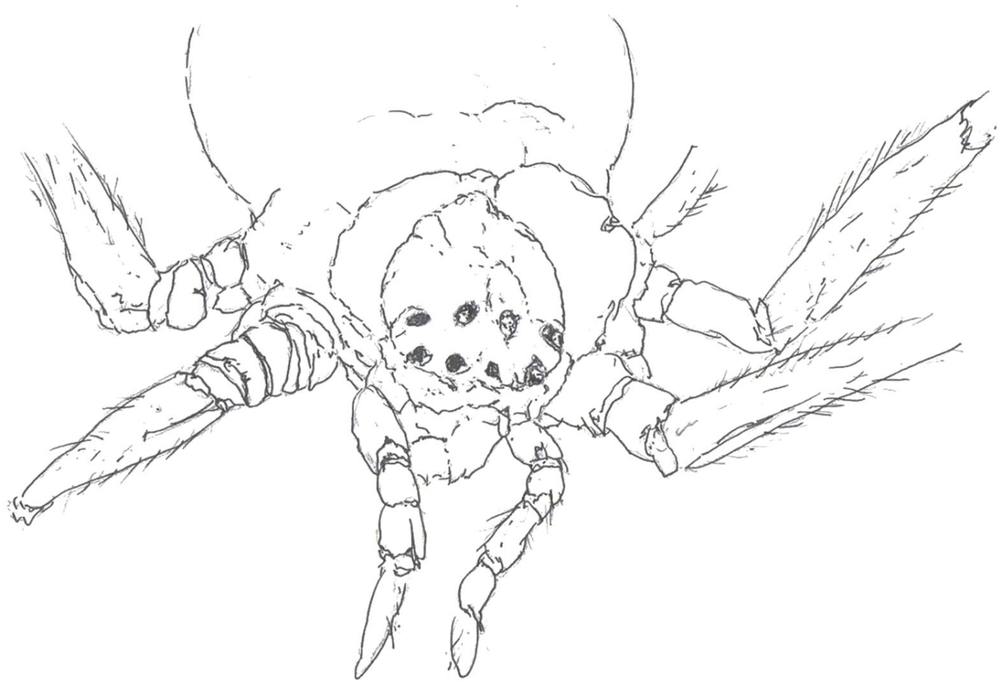
SPIDER ANATOMY DIAGRAM #2



BLACK WIDOW ANATOMY

1. EIGHT LEGS TIPPED WITH CLAWS. EACH LEG HAS SEVEN SEGMENTS
2. CEPHALOTHORAX. CONTAINS MANDIBLE, JAWS, BRAIN, EYES, STOMACH AND LEG ATTACHMENTS.
3. PEDICAL (WAIST)
4. DISTINCTIVE "HOURGLASS" MARK
5. SPINNERETS (SILK GLANDS)
6. ABDOMEN. CONTAINS GUTS, REPRODUCTIVE ORGANS, HEART AND SILK GLANDS

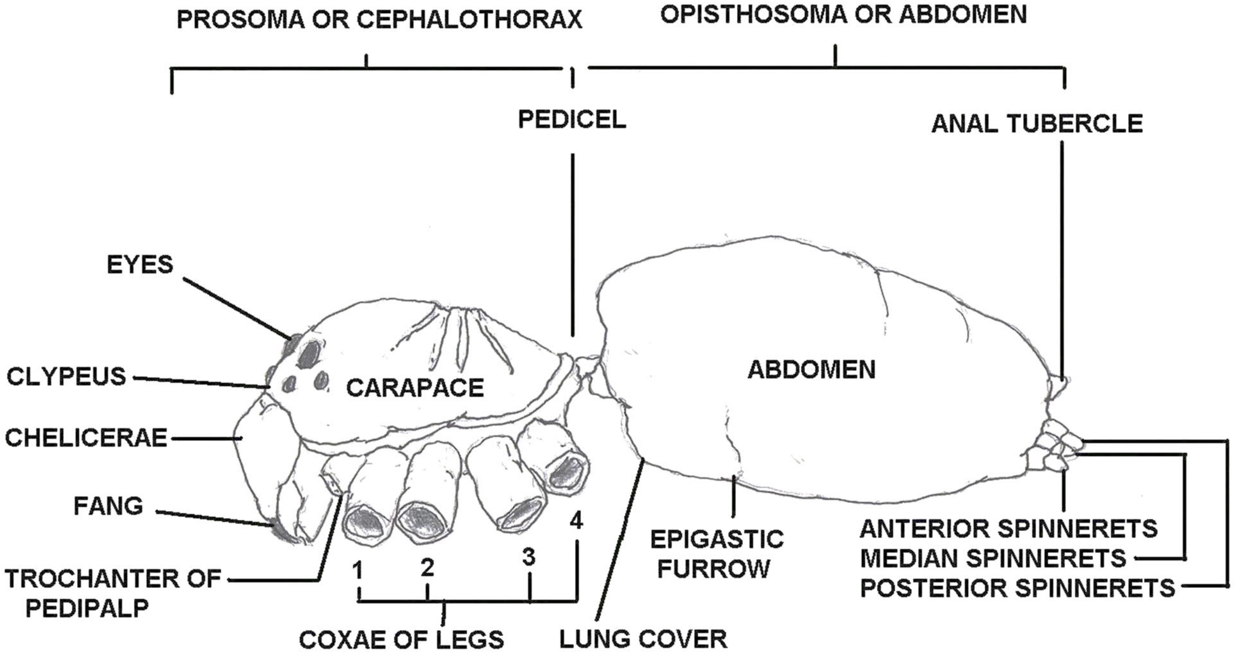
SPIDER ANATOMY DIAGRAM #3



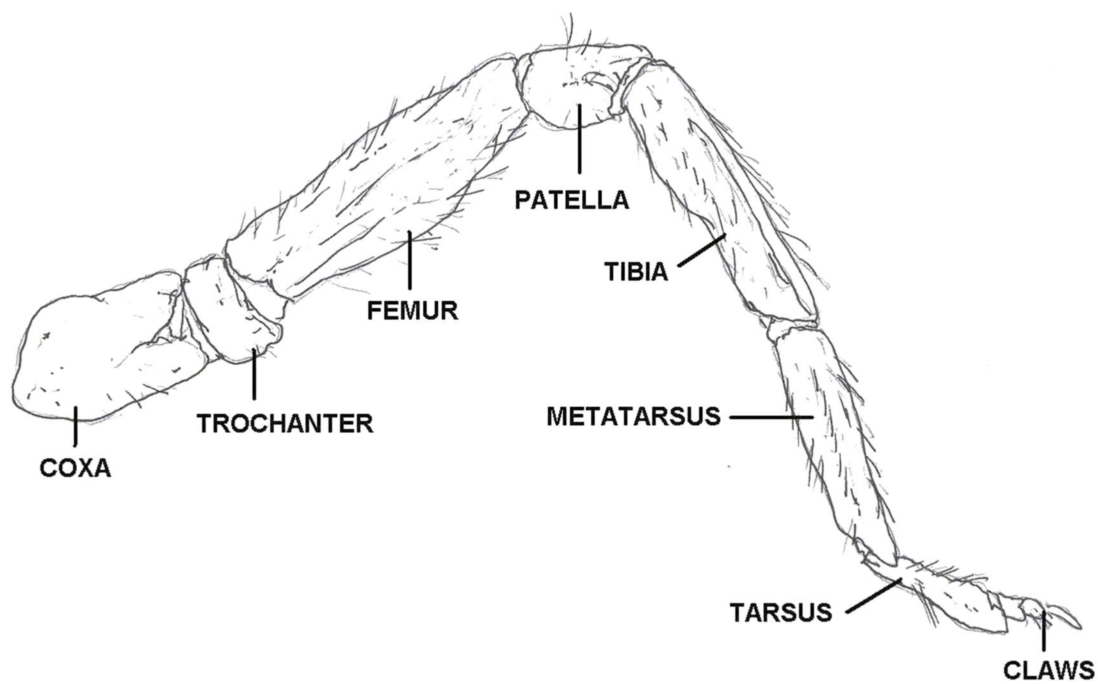
CLOSE-UP VIEW OF BLACK WIDOW EYES

CLOSE-UP VIEW OF BLACK WIDOW'S CLAWS

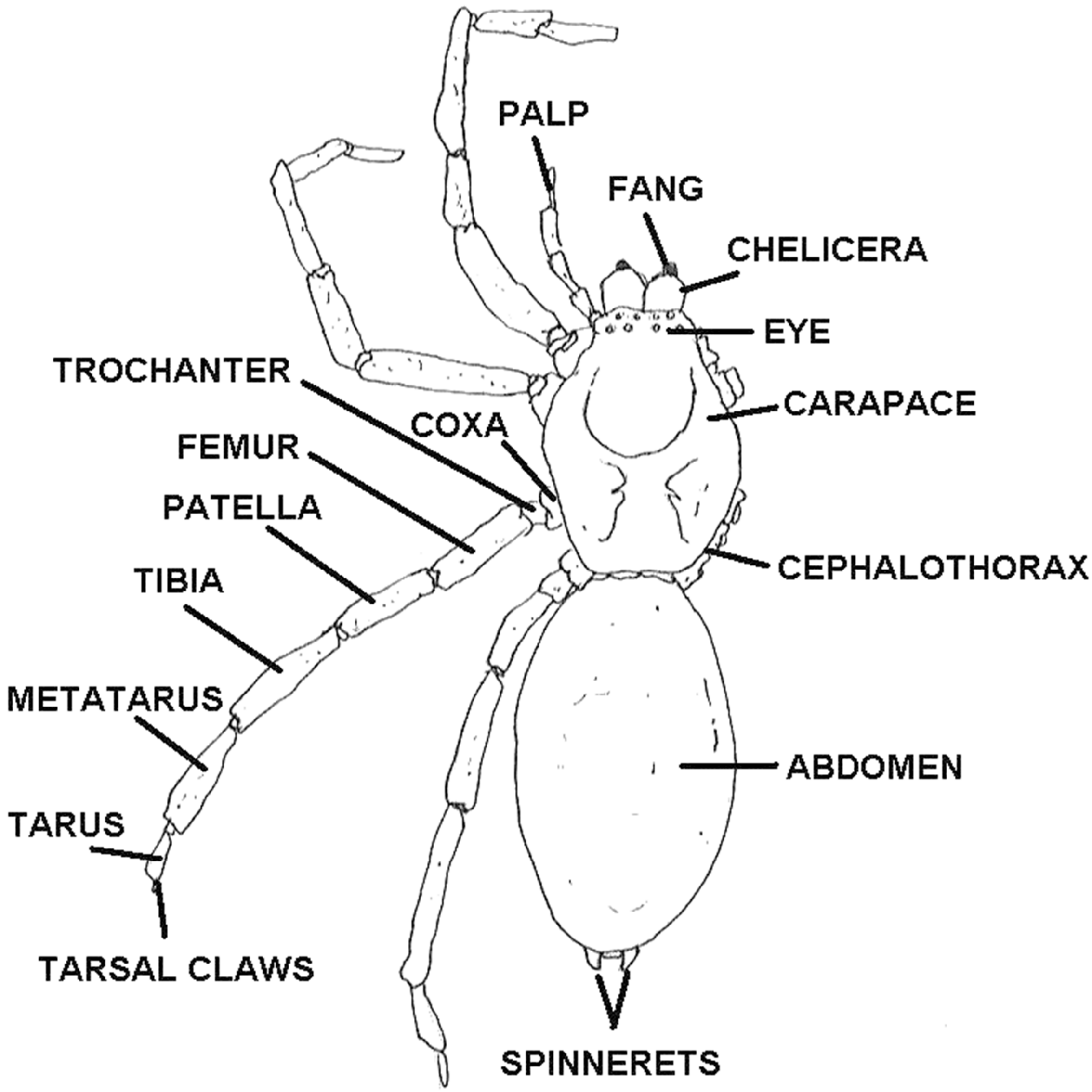
SPIDER ANATOMY DIAGRAM #4



SPIDER LEG



SPIDER ANATOMY DIAGRAM #5

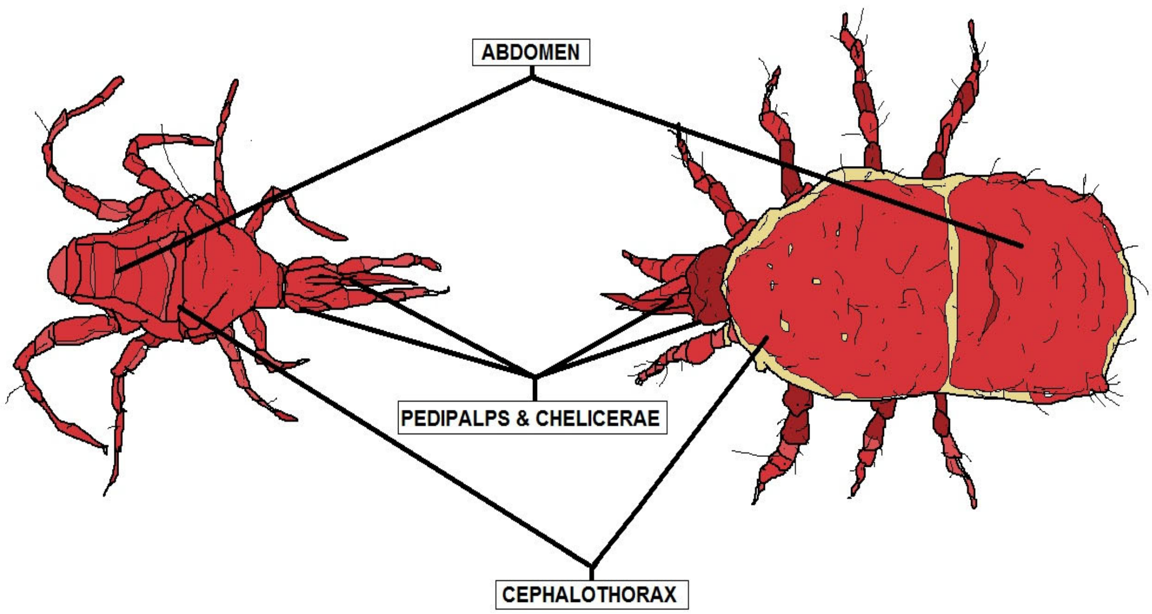


SPIDER ANATOMY DIAGRAM #6

Chelicerata

The Chelicerata, which is called a subphylum here for convenience, but which called a phylum in some texts, is an extremely ancient group of arthropods, including the extinct Eurypterida. The Chelicerata includes spiders and scorpions, mites and ticks, horseshoe crabs, daddy-longlegs, and extinct "*sea-scorpions*", to name a few. It is the second most prominent order of terrestrial arthropods, after the uniramians.

They are now distinguished from the other arthropod groups by the possession of (at least) six pairs of appendages. These normally include four pairs of walking legs, a pair of chelicerae and a pair of pedipalps. They have no mandibles and no antennae and the body is divided into two, not three, sections, as in the Uniramia. They are, however, normally bilaterally symmetrical, have a through gut, have uniramous appendages, a non-calcareous exoskeleton, and are gonochoristic.



MITE AND TICK BODY REGIONS

No chelicerates possess jaws for biting and chewing, but suck up their food in liquid or semi-liquid form. However, this food may have been seriously torn up by the chelicerae before ingestion.

Most species go in for external digestion to some extent, meaning they secrete digestive juices onto the food item as it is held close to the mouth or inject digestive juices into their prey's body, and suck up the half-digested soup that results.

The inclusion of the class Pycnogonida in the Chelicerata is generally accepted but not scientifically proven; the fossil record for pycnogonids is very scant and they differ in many ways from the other chelicerates. The Chelicerata contain more than 80,000 species known to science, most of which are Arachnids divided almost evenly between the spiders and the mites.

Phylum Arthropoda; Subphylum Chelicerata	
Class Merostomata (Horseshoe Crabs)	5 species
Class Arachnida (Spiders, Mite, Scorpions etc.)	80,000 species
Class Pycnogonida (Sea Spiders)	1,000 species

More on Chelicerates
Chelicerates occupy a variety of roles in the ecology of marine and terrestrial systems. While many spiders build webs, others do not, but instead ambush prey as it passes by. This is also the tactic used by scorpions, another group of chelicerate predators.

The predatory habits of these incredible critters helps to control insect populations in many parts of the world. Some arachnid chelicerates are parasites, such as ticks and mites. They live upon the bodies of other animals and feed on the blood, skin, or hair. Some of these carry diseases, which they pass on to the host when they feed. Still other chelicerates are tiny organisms that feed on detritus, the bits of decaying matter that accumulate on and below the ground.

The first terrestrial chelicerates are believed to have been detritus feeders. Parental care is not common among the chelicerates, but some scorpions will carry their young on their backs for a time. In most cases, however, no such care is provided, and the young must fend for themselves from the time they hatch. Survival is then dependent on the fact that large numbers of eggs are produced at a time, and it is likely that at least a few will survive.

Spiders are Harmless
Most spiders found in the United States are harmless, with the exception of the black widow and the brown recluse spider. The brown recluse spider — a tiny oval brown spider with a small shape like a violin on its back — is found mostly in midwestern and southern parts of the United States. The bites usually don't hurt at first, and a child might not even be aware of the bite, but in some cases they cause swelling and changes in skin color and a blister.

The black widow spider, which is found all over North America, has a shiny black body and an orange hourglass shape on its underbelly. The venom (poison) in a black widow bite can cause painful cramps that show up within a few hours of the bite. The cramps can start in the muscles around the bite and then spread. The bite may also lead to nausea, vomiting, chills, fever, and muscle aches. If your child has any of these symptoms — or you know that he or she has been bitten — go to the emergency room right away.

Spider’s Life

What infinite care the Creator has taken in the design of the spider! This little creature breaks the rules of the evolution model with its marvelous complexity for the spider with all its abilities and peculiarities. As does each species of spider, it has its own unique web, which may be spun more than two feet in diameter. At the center of the web, the spider makes a dense area of silk that often gives the appearance of a zipper or zigzag bulk of silk. There is no way a spider’s silk gland could have evolved or the spider’s skills for web spinning.

The female weaves an egg sac that is pear-shaped and about one inch in diameter. She then hangs the egg sac somewhere close to her main web. This spider lays all her eggs at once. There are usually 40 or, 50. As each egg is expelled, the female dusts it with a powdery substance. This dusting gives the egg a coating that looks like the bloom on a plum or a grape. The eggs are enclosed in a silken cup at the center of the sac. The cup, in turn, is covered by a layer of flossy silk. And for additional protection the female weaves another layer of silk around both the cup and the floss. This outer covering is tightly woven and brown in color. Shortly after the eggs are laid they hatch. The young are known as spiderlings. They break out of the shells by means of an organ known as the “egg tooth.” This later disappears.

The black and yellow garden spider is like a miniature manufacturing plant. It produces different kinds of webbing in more than one color for different purposes, as well as making the powdery substance with which it coats its eggs. *Will Barker, Winter-Sleeping Wildlife (New York: Harper and Row, Pubs., 1958), pp. 94- 96.*

Some of its webbing is sticky to entrap insects for food. Other parts of the web are not sticky, enabling the spider to move rapidly across the web without ensnaring itself. How does evolution (the impersonal plus time plus chance) explain the complicated ability of one spider to produce different types of webbing for different purposes and even in different colors (varying from white to brown)? And how does evolution explain the presence of an “egg tooth” in a baby spider?

When the spider decides it is time to move on to new territory, it has an ingenious means of travel: To reach new locations the spider travels by a means of transportation known as “ballooning.” A spiderling or spider throws out streams of silk. These threads form a sort of “flying carpet.” It rises on warm currents of ascending air, and spiders and spiderlings are borne aloft and scattered far and wide. Sometimes they go as high as 14,000 to 15,000 feet and travel hundreds or even thousands of miles.

Spider Habitat

Spiders can be found in nearly every conceivable kind of habitat. The limiting factor appears to be the lack of available food to prey upon. Many species live outdoors under natural surroundings and seek shelter in ground litter, vegetation under rocks, or in crevices. Those species that build webs may construct them in vegetation or are associated with human dwellings. A few species, such as the house spider, cellar spider, and brown recluse, have adapted to living inside houses. They take advantage of the protection and warmth that our houses provide. It has been stated that usually we are never farther than about eight feet from a spider during most of our lives!

A vegetarian spider species was described in 2008, but all other known species are predators, mostly preying on insects and on other spiders, although a few large species also take birds and lizards.

Spiders use a wide range of strategies to capture prey: trapping it in sticky webs, lassoing it with sticky bolas, mimicking the prey to avoid detection, or running it down. Most detect prey mainly by sensing vibrations, but the active hunters have acute vision and hunters of the genus Portia show signs of intelligence in their choice of tactics and ability to develop new ones. Spiders' guts are too narrow to take solids, and they liquidize their food by flooding it with digestive enzymes and grinding it with the bases of their pedipalps, as they do not have true jaws.

Male spiders identify themselves by a variety of complex courtship rituals to avoid being eaten by the females. Males of most species survive a few matings, limited mainly by their short life spans. Females weave silk egg-cases, each of which may contain hundreds of eggs. Females of many species care for their young, for example by carrying them around or by sharing food with them. A minority of species are social, building communal webs that may house anywhere from a few to 50,000 individuals. Social behavior ranges from precarious toleration, as in the aggressive widow spiders, to co-operative hunting and food-sharing. Although most spiders live for at most two years, tarantulas and other mygalomorph spiders can live up to 25 years in captivity.

Biology
Spiders range in size from less than 1.0 mm (0.04 in) to more than 10 cm (4 in) in length, with a leg span of up to 20 cm (8 in). A spider’s body is divided into two parts: the front portion, called the prosoma or cephalothorax, and the rear portion, called the opisthosoma or abdomen. A narrow stalk called the pedicel connects these two parts.

A hard shell, called an exoskeleton, covers the entire body of a spider. The exoskeleton is made of cuticle, a material composed of a combination of protein and tough fibers called chitin. The cuticle forms thin layers stacked on top of one another, an arrangement that improves the strength and elasticity of the exoskeleton. The spider’s cuticle provides attachment sites for many muscles, and it also prevents *desiccation* (loss of body water). The cephalothorax cuticle is strong and stiff, while the cuticle of the abdomen is soft and extensible. As a spider grows, it sheds or molts its exoskeleton and grows a new one to cover its larger body.

Cephalothorax Structures
The cephalothorax contains a number of structures and appendages: one pair of biting mouthparts known as chelicerae; a pair of poison glands; one pair of short, leg-like appendages called pedipalps or palps; and four pairs of legs. The spider’s eight eyes are also located on the cephalothorax.

Mouthparts
When a spider catches prey, it uses a pair of jointed appendages known as the chelicerae, located in front of the mouth opening. Chelicerae resemble tiny pocketknives. Each chelicera has a sharp fang that swings out of its resting position to stab into the victim. Near the tip of the fang is a duct opening that comes from a poison gland. The fang acts like a hypodermic needle—it ejects venom from the poison gland and delivers it into the prey. Spiders also use chelicerae as multipurpose tools. They have been called the “*hands*” of the spider. Spiders can use their chelicerae to perform tasks such as digging burrows in the soil and transporting small prey.

Poison Glands
Most spiders have a pair of poison glands that lie within the cephalothorax. Each bulblike poison gland produces and stores toxin. A muscle spirals around the gland. When this muscle contracts, it squeezes poison from the gland through a duct into the fangs of the chelicerae, which then pass the poison into the prey.

Palps and Legs
Behind the chelicerae is a pair of palps, segmented limbs that are used in feeding and as feelers. Male spiders also use palps to transfer sperm to females during mating. Adjacent to the palps are four pairs of long, hairy legs. Unlike human hair, each spider hair found on the legs acts as a sensory organ, sensitive to touch and vibration. Each leg is made up of seven jointed segments, called the coxa, trochanter, femur, patella, tibia, metatarsus, and tarsus. More than 30 muscles control the movement of each leg. In addition, some joints of the leg move by the hydraulic action of body fluid. The tips of the legs have two or three small claws that are used for climbing or grasping the spider's silk thread. Many ground spiders have specialized adhesive hairs beneath their claws, known as claw tufts or scopulae. These claw tufts enable the spiders to walk sure-footedly on smooth, vertical surfaces—even upside down on glass.

Sensory Organs
Most spiders are active at night, and as a result, they use their other senses more than they use their eyesight, which is not well developed. In addition to the thousands of hairs found on the palps and legs that are highly sensitive to touch and vibrations, spiders also have hairs on their feet that they use to taste things.

Most spiders have four pairs of simple eyes (eyes with a single lens) that are located on the front of the cephalothorax. The eyes are usually grouped into two or three rows that form specific patterns in different spider families. This eye arrangement is often used to identify and classify a spider.

Unlike spiders that are active at night, spiders that are active during the day, such as jumping spiders and lynx spiders, typically have good vision at close range (around 10 to 20 cm, or 4 to 8 in). Their vision easily rivals the eyesight of many insects, which have *compound eyes* (eyes with multiple lenses).

Spider's Abdomen
The spider's abdomen is soft and saclike. On the underside of the tip of the abdomen are three pairs of spinnerets. Each spinneret is studded with many fine, hair-like tubes called spigots, which produce a variety of silk threads. The spigots lead to several large silk glands inside the abdomen. Silk is formed as a liquid inside these abdominal glands. As the silk is drawn out through the spigots, protein molecules within the silk line up parallel to one another, causing the silk to harden and form strong, elastic filaments. The hardening of silk results from the drawing-out process through the spigots, not from exposure to air, as is commonly believed. Several silk threads produced by different spigots may fuse to form a stronger one. Spinnerets are actually shortened limbs. They can move to place silk strands in precise locations when the spider builds a web or wraps prey in silk.

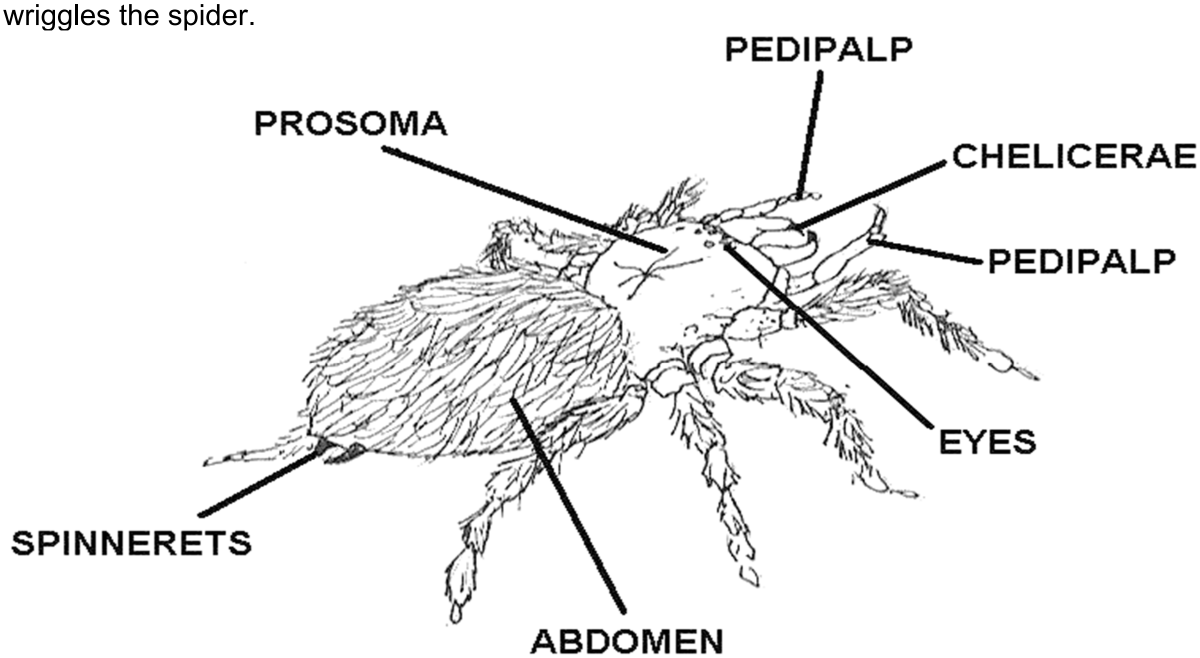
Internal Anatomy and Function
The cephalothorax houses part of the digestive system and the central nervous system. The abdomen contains most of the spider's vital organs, including a long, tubular heart; respiratory organs; reproductive organs; and excretory organs.

Breathing Organs
Spiders use two types of breathing organs: book lungs and tracheal tubes. Narrow slits on the underside of the abdomen lead to two or four respiratory organs called book lungs. These organs are so named because they consist of alternating layers of air spaces and thin leaflets of cuticle filled with blood, making the structures resemble a slightly opened book. Oxygen from the air passes through the extremely thin cuticle leaflets directly into the blood. A small opening in front of the spinnerets, known as a spiracle, leads to tracheal tubes made of cuticle. These tiny tubes branch and spread throughout the body. Air enters the spiracle and passes through the tracheal tubes so that oxygen can travel to all the spider's body tissues.

Moulting
Spiders undergo several moults before they are fully grown. If they do not shed their skin, they die. How would the spider know this until it grew too big for its shell and died? Dead spiders do not evolve new abilities! The skin moults and splits open in a special manner. First, the spider injects a certain liquid called "moulting fluid" between its outer old skin and its newly developing skin. Where does this special fluid come from, and how does the spider know what to do with it and when to use it? Using the moulting fluid too soon or too late is fatal!

The way that the old skin splits is crucial. If it cracks open in the wrong places, or at wrong angles, the spider perishes. Once the old skin is sufficiently loose, splits appear along the sides of the body and in front of the eyes. But no horizontal split occurs across the body.

The vertical split along each side of the body and the one crosswise in front of the eyes form a flap of skin. The spider pushes up the flap like a man thrusting up a hinged trap door. It pushes and pushes and pushes until the flap drops back over the abdomen. Out of the opening wriggles the spider.



SPIDER ANATOMY #3

Spider's Blood

Spider blood, also known as hemolymph contains many blood cells with oxygen-carrying pigments called hemocyanin, which give the blood a light blue color. In contrast, the primary components of human blood are red blood cells carrying the red pigment hemoglobin. Spider blood also contains many other types of blood cells that play a role comparable to that of the white blood cells of humans. Among other functions, these cells play a role in blood clotting after an injury.

The spider's long, tubular heart lies toward the back side of the abdomen. When the heart contracts, it pumps blood forward into the cephalothorax and backward into the abdomen. Blood travels through closed tubes, or arteries, into spaces in the body cavity. From these spaces the blood travels to the book lungs, where it releases carbon dioxide and picks up a fresh supply of oxygen before returning to the heart.

Digestive System

The digestive system consists of a branched tube that extends from the mouth to the anus. In the cephalothorax, the tube enlarges to form a stomach with powerful muscles. When these muscles contract, they produce a powerful sucking action that pulls food into the midgut. Spider digestion is unusual in that it begins outside of the spider's body. When a spider captures an insect or other animal, it uses its chelicerae to pierce the prey and inject poison into the wound to paralyze or kill the animal. The spider then vomits juices containing digestive enzymes into the wound of the victim to break down and liquefy its body tissue.

This liquefied tissue is then drawn through the spider's mouth and into its body by the sucking action of the stomach. Two mechanical filters in the mouth prevent solid food particles from passing into the digestive system. From the stomach, food passes into the midgut, which branches throughout the entire body. Enzymes secreted by the midgut further break down the liquefied food into nutrient molecules small enough to pass through the walls of the midgut into the blood. Nutrients can be stored for a long time in the spider's extensive digestive system, enabling many spiders to go for weeks or even months without the need to catch any prey.

Nervous System

Most arthropods have a central nervous system made up of a long chain of nerve cell centers, called ganglia that run throughout the body. In spiders, the ganglia are concentrated in the cephalothorax, where they condense into two compact masses: the sub-esophageal ganglion and the supra-esophageal ganglion. The sub-esophageal ganglion directs spider locomotion. The supra-esophageal ganglion is considered the brain of the spider. Sense organs throughout the body send information to this nerve center, where information processes and complex functions begin.

Spider's Brain

A spider's brain is relatively highly developed, enabling spiders to easily adapt to changes in their environment. Some scientists believe spiders can learn, and some have observed that spiders can remember where in their web they have stored captured prey; if the prey is removed, the spiders will continue searching for it in the same place for hours.

Spider Reproduction

All species of spiders have two separate sexes, and the males are usually smaller than the females. The male spider has two sperm-producing testes. A sexually mature male spider uses its large palps to transfer sperm cells into the female during mating. In this process, the male builds a small, triangular sperm web, onto which he deposits a drop of sperm from his abdomen. He then dips both palps into this droplet, drawing sperm cells into the palps as if by a tiny pipette. The female reproductive system includes two egg-producing ovaries. After the male transfers sperm cells into the female's genital opening, located on her abdomen, they are stored, sometimes for months, in tiny receptacles. These sperm cells fertilize the female's egg cells just before she deposits her eggs into a silky cocoon.

Life Cycle
The life cycle of the spider consists of four stages: egg, larva, young spider, (known as a nymph or spiderling), and adult. Like insects, spiders grow only by molting, a process that involves periodically shedding their exoskeleton. In each molting stage, young spiderlings resemble tiny adults, a process known as incomplete metamorphosis.

Courting and Mating
Spiders become sexually mature after their last molt, at which time females have developed functional ovaries and males have mature testes. In most spider species, the male courts the female before mating occurs. After a male spider has filled its palps with sperm cells, he begins searching for a female. A male begins by identifying himself to a female so that she does not mistake him for potential prey. In some spiders, such as American tarantulas, this identification process involves the male repeatedly touching the female. More often, a male courting a female communicates with her over larger distances using vibrations.

For instance, a male wolf spider uses its legs to drum on the ground. In some web spiders, the male attaches a special signal thread to the female's web. The male then drums or plucks the thread in a rhythm that indicates the vibration is caused by another spider of the same species and not by an ensnared insect. If a female is ready to accept a courting male, she may send signals back to him.

Locating the right female can be tricky for a male spider. Fortunately, female spiders produce certain chemical substances, known as pheromones, that aid spider courtship. A female may release these pheromones through the air (like a perfume) or she may deposit them on her silk threads. When a male spider encounters pheromones from a female of the same species, he becomes excited, even if the female is not present.

Spiders with better eyesight may rely mostly on visual signals during courtship. When a male notices a female, he starts a zigzag dance in front of her in which he raises his front legs, vibrates his palps, and twitches his abdomen. Each species uses a different courtship dance with unique movements. A female will only accept a male who performs a dance with movements specific to that species. When a male finds an interested female, he inserts his sperm-containing palp into the female's genital opening. The process of mating can be very brief (a matter of seconds), or it can last several hours, depending on the species. In most species, both sexes separate peacefully after mating. Contrary to popular belief, the female black widow spider does not necessarily kill her partner after mating. Depending on the species, a female may mate only once or she may mate with several males during her lifetime.

Eggs and Brood Care
In most spider species, a female determines when sperm cells from the female's receptacles will fertilize her egg cells. Fertilization may occur a few weeks after mating, a strategy that enables the female to lay her eggs when she deems external conditions are best. The female then lays her eggs. Most spider species lay several hundred eggs; species of large spiders deposit several thousand within just a few minutes.

Typically, the female spider lays her fertilized eggs in a silky case called a cocoon, which provides a protective and insulating environment for the developing spiders. Many females abandon their cocoons right after they deposit their eggs, although they may camouflage them or hang them in hidden locations. Other spiders guard and defend their cocoons until the eggs hatch.

Some spiders exhibit special brood care. Female wolf spiders attach their cocoons to their spinnerets and carry them around until the eggs hatch. The newly hatched spiderlings then climb onto their mother's back, where they stay for about a week before they leave to survive on their own. Occasionally, young spiderlings stay in their mother's web for weeks. During this time, the mother feeds her brood, transferring regurgitated food from her mouth to their mouths.

Development and Growth

Spider eggs hatch inside the cocoon. The first stage hatches from the egg as an immobile, milky white larva. Larvae are covered by an embryonic membrane and receive nourishment from yolk material within their abdomen. After one to two molts over about a two-week period, the larva changes into a mobile spiderling, also referred to as a nymph.

In order to grow to an adult size, spiderlings undergo a series of molts that enables them to increase in size. During molting, the old cuticle slowly lifts off, while a thin new cuticle forms underneath. The new cuticle is wrinkled and pliable at first, but as molting progresses and the spiderling grows, the new cuticle stretches to accommodate the larger spiderling body. It later hardens into a new rigid exoskeleton that encases the larger spiderling. The number of molts between the spiderling and adult stage varies according to the size of the species. Small species may molt about five times, while some large tarantulas may molt as many as 40 times.

For most spiders, a spiderling's last molt marks adulthood, when functional sexual organs have developed and growth halts. Some adult female spiders, such as American tarantulas, continue to molt repeatedly. Most spiders live only 1 or 2 years. Notable exceptions are large female tarantulas, which can live up to 20 years. Male tarantulas live only 2 to 3 years. Many male spiders die soon after mating.

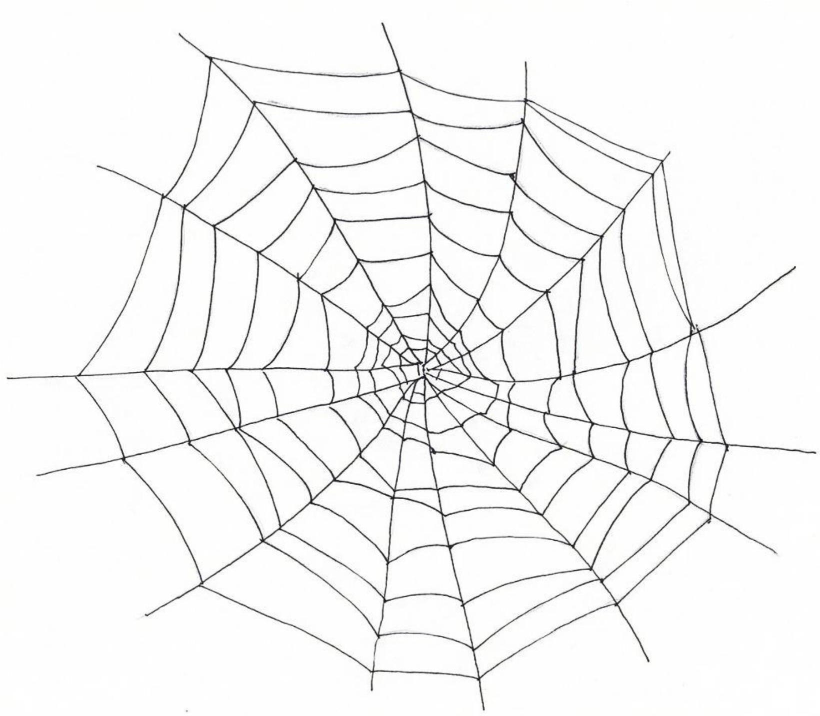
Behavioral Characteristics of Spiders

Most species of spider are active at night and all are predatory, feeding on a wide range of other invertebrates. Cannibalism may also occur among spiders especially where there is overcrowding. Different species of spiders use a variety of methods to capture their prey, but most usually construct sticky silk webs or threads to trap potential prey. Other species chase their prey often capturing them with rapid lunges.

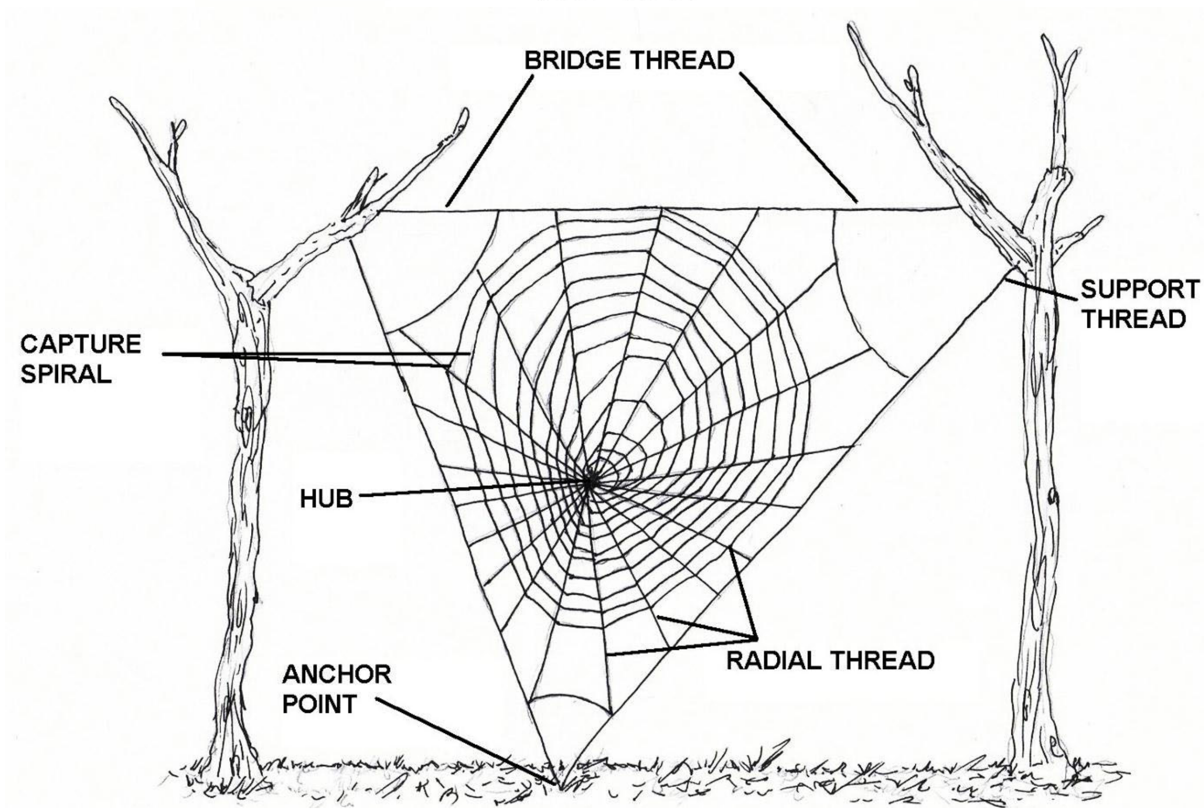
The venom that spiders produce is predominantly used to kill or immobilize their prey by being injected through hollow fangs into the captured animal. The prey is then squeezed or held by the strong basal section of the fangs and saliva in the spiders' upper lip digests the body contents. The insides of the victim are then consumed and the hard outer body discarded.

1) All spiders are predatory, feeding on other smaller animals. Some spiders, for example, the orb weavers, spin silk webs in which to catch prey. Others, such as wolf spiders and jumping spiders, hunt down their prey.

2) Spiders kill their prey by injecting them with venom from their poison glands. The venom is injected using their fang-like chelicera.



ORB WEB



WEB DESIGN DIAGRAM #2

Spider Web Sub-Section

Spider webs can be quite delicate, or exceptionally strong, depending on the species and age of the spider. Webs of black widows, for example, are expansive (usually about a cubic foot) and incredibly elastic. You can pluck the threads like guitar strings without breaking them. The webs of Nephila orb weavers from tropical regions are so strong that native peoples in Papua New Guinea use them as handheld fishing nets. Spider silk is widely regarded as the strongest natural fabric known, at least half as strong as a steel thread of the same thickness, and much more elastic. Efforts to synthesize spider silk have met with mixed results, but it is not out of the question to imagine a future with bullet-proof vests and parachutes made of spider silk.

Silks, Threads, and Webs
Nearly all spiders produce silk composed of the protein fibroin. This is the same protein produced by silkworms, the larvae stage of certain silk moths. Each spider has four to eight different kinds of silk glands in its abdomen, and each gland produces a different type of silk with different properties. For instance, spiders lay out a line of dry silk behind them as they move about. This dragline acts as a safety line like that used by a mountain climber. Other glands produce cocoon threads that blanket and protect fertilized eggs. Still other glands produce sticky capture threads that ensnare prey.

Spider silk threads are very thin, about 1 micrometer (0.01 mm) in diameter. Each thread weighs very little. A spider web composed of 20 m (70 ft) of silk thread weighs less than 1/1000 of a gram or 1 milligram. Despite its lightness, a spider silk thread is as strong as a nylon thread, but with more elasticity. The combination of strength and elasticity makes spider silk ideal for web building. Spider threads are tough enough to withstand the impact of a flying insect, while being elastic enough not to tear apart with the captured prey's weight.

Types of Spider Webs
Web patterns vary considerably, depending on the species of spider. Perhaps the most recognizable web is the almost circular orb web, in which an outer framework supports a continuous spiraling thread and a series of threads radiating from the center of the web. Other web types may have a more irregular shape. Some spiders build irregular, flimsy webs.

Common house spiders construct funnel webs, flat silk sheets with a raised tube in the corner that serves as a retreat for the spider. Cobweb spiders build an irregular silk meshwork with sticky threads at the bottom that trap insects. Sheet web spiders construct a horizontal silk sheet with a dome, from which the small spider hangs upside down. Many spider webs are found near the ground or in low vegetation, although orb webs often span the open spaces between bushes or trees in order to trap flying insects. The size of a web depends on the size of the spider. Whether the web has a tight or wide mesh depends on the size of the prey the spider expects to capture.

Web Building
Web building is a complex process, but some spiders can complete a web in less than 30 minutes. Spiders typically build their webs at night, completely relying on their sense of touch, not eyesight, during construction. Each type of spider uses a different procedure when building a web. Spiders that weave orb webs generally begin by spinning a thread that is carried by air currents until it catches on a tree limb or other firm support. From this thread, the spider lays down another thread to form a Y-shaped structure that is the basic framework of the web.

The spider then climbs to the midpoint of the Y-structure, known as the hub, and begins creating radius lines, or spokes, around the web. As the spider builds radius lines, it connects these lines with a few narrow circles of thread in the center of the web that forms the auxiliary spiral. The auxiliary spiral prevents radius lines from sagging when the spider walks on them. Using the auxiliary spiral as scaffolding, the spider begins the formation of the catching spiral, fastening sticky threads to each radius line. As the spider constructs the catching spiral, it dismantles the auxiliary spiral.

The catching spiral extends from the periphery of the web and stops short of the web's hub. In the finished web, only remnants of the auxiliary spiral remain and there is an empty space in the web's center known as the free zone. The spider may sit upside down with its legs placed in the center of its web to detect vibrations in the web when prey gets caught in the sticky catching spiral. Others may hide nearby under a curled leaf and use the vibrations from a signal thread attached to the hub to stay informed when prey has struck the web. The orb web is built anew every day. Some species eat their old web before starting a new web, while others roll up the web and discard it as a tiny silk ball.

Spider Web Types
Many spiders are classified by the type of webs they weave, the different types of webs are:

- Sheet webs
- Dome or tent webs
- Tubular webs
- Funnel webs
- Tangle webs or cobwebs
- Spiral orb webs

Depending on the type of spider, several different types of silk may be used in constructing a web such as a sticky capture silk to a fluffy capture silk. Webs may be constructed horizontally, normally sheet webs, or vertically, predominately orb webs, or any other angle in between.

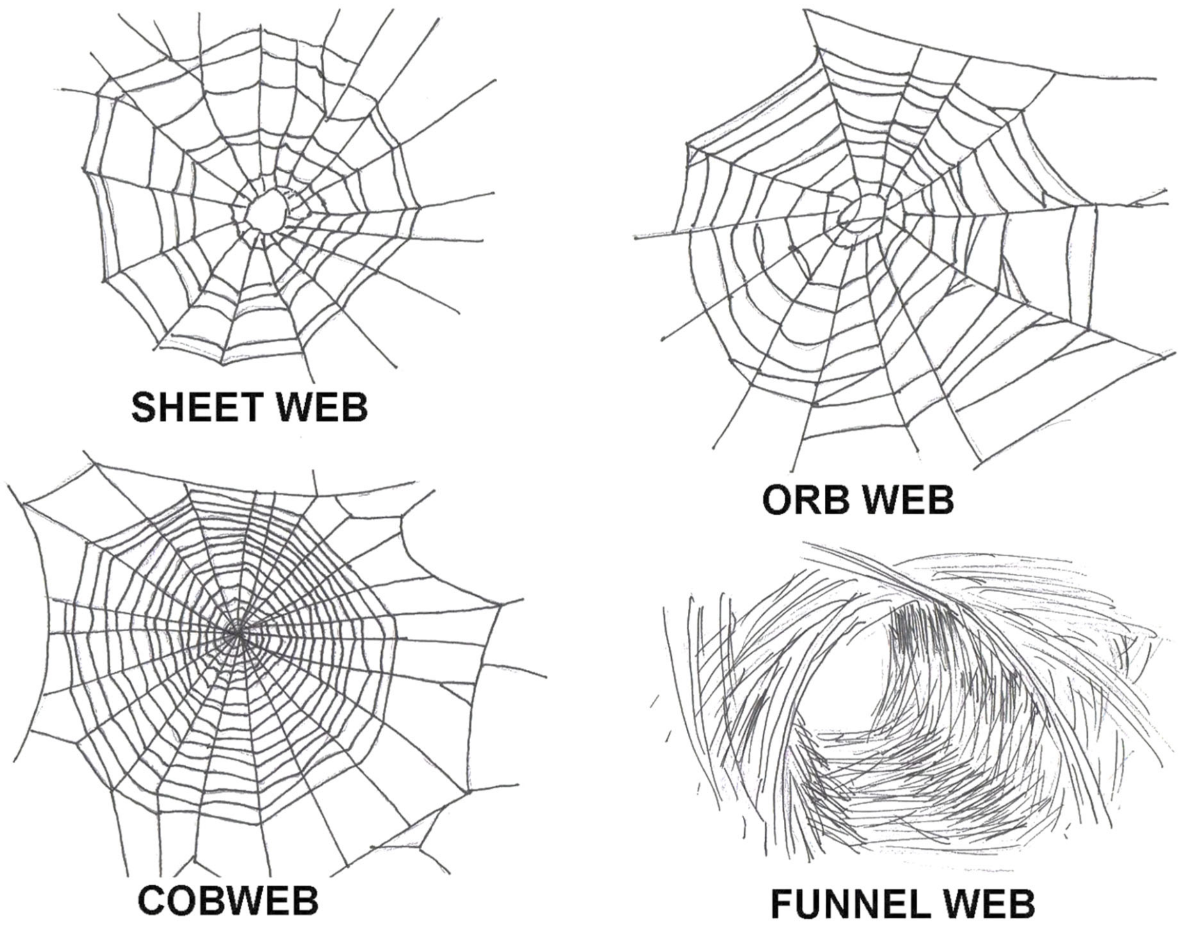
Constructing an Orb Web
During the making of the orb web, the spider will use itself for measurements. The majority of webs made by spiders span gapes they could not have easily crawled between. They accomplish this by first letting out a fine and very adhesive thread that will drift on the finest breeze across a gap. As soon as the thread has stuck to a suitable position, the spider will walk along it carefully while strengthening it with a second thread. The spider will continue backward and forward strengthening the line in order for it to support the rest of the web. After this thread is strengthened, the spider will continue to construct a Y-shaped netting. With this complete, the web can now be constructed, with more radials being added with the distance between each being small enough to cross. The size of the spider and the web determines how many radials there will be.

Once all the radials are in place, the spider will then move on to fortifying the center of the web with around five circular threads. After, the spider will spiral outwards using a non-sticky web, with widely spaced threads to be used for moving around the web during construction working from the inside to out. Then working from the outside in, the spider will replace the non-sticky guide web with a stick web spaced closer together. The spacing between each spiral will be proportionate to the distance from the tip of its back legs to its spinnerets. This is one of the ways in which the spider will use its self for measuring.

Once the web is completed, the spider will chew of the initial three center spiral threads then sit and wait for its prey. During construction, if the web becomes broken but without structural damage, the spider will not initially attempt to fix the problem. After having made the web, the spider will wait on or near the web for its prey to fall victim to its sticky trap. Once its prey has become trapped, the spider will initially feel the vibrations from the impact and then the struggle.

Spiders do not normally stick to their own webs thou they are not immune to sticking to them. When moving around there webs they must be careful so not to get stuck by using non-sticky threads in their webs.

A spider that positions its self at the center of the web is very visible to predators such as birds; many orb web spiders that hunt during the day will reduce this risk by hiding at the edge of its web, with one foot on a signal line from the center of the web.



TYPES OF SPIDER WEBS

Spider Web Uses

Some species of spiders do not use their webs for catching prey directly, some spiders pounce from hiding such as trapdoor spiders, or some chase down their prey such as the wolf spider. The Net casting spider uses both methods for catching its prey.

The Net casting spider will weave a small net that it attaches to its front legs, it will then lurk in wait for potential prey, when potential prey comes along, and the spider will lunge forward at its prey and wrap its victim in the net, followed by biting and paralyzing its victim. Using this technique, the Net casting spiders' uses less energy. They don't lose energy building a whole web and they don't loss energy from chasing down prey.

Some spiders don't even spin a web, they use the signaling technique. There are several types of water dwelling spiders that rest their feet on the surface of the water. Then when an insect falls into the water and breaks the water's surface tension, they become trapped; the spider senses the vibrations through the water and runs out to capture the prey.

Spiders webs are rich in vitamin K which can be very effective at clotting blood, in traditional European medicine, webs were used to help heal wounds and cuts and to reduce bleeding.

Communal Spiders Webs
Spiders may build webs together occasionally, in the same area. One measuring 500 feet (180 meters) across was reported at Lake Tawakoni State Park in Texas.

Enemy of Spiders
The greatest enemy of spiders, aside from frightened human beings, might be other spiders. Even some web-weaving spiders, such as cellar spiders in the family Pholcidae, can leave their own webs to stalk other spiders in their webs. Thread-legged assassin bugs in the family Reduviidae patiently approach spiders in their webs and then nab them lightning-fast with their vise-like front legs.

Giant tropical “helicopter” damselflies hover in front of spider webs and pluck the spider off. Mud dauber wasps tug on spider webs to mimic an entangled insect, then grab the spider and sting it into paralysis. The immobile spider is then stored in a nest as food for the wasp's offspring. Huge, colorful “tarantula hawk” wasps tackle the largest of spiders.

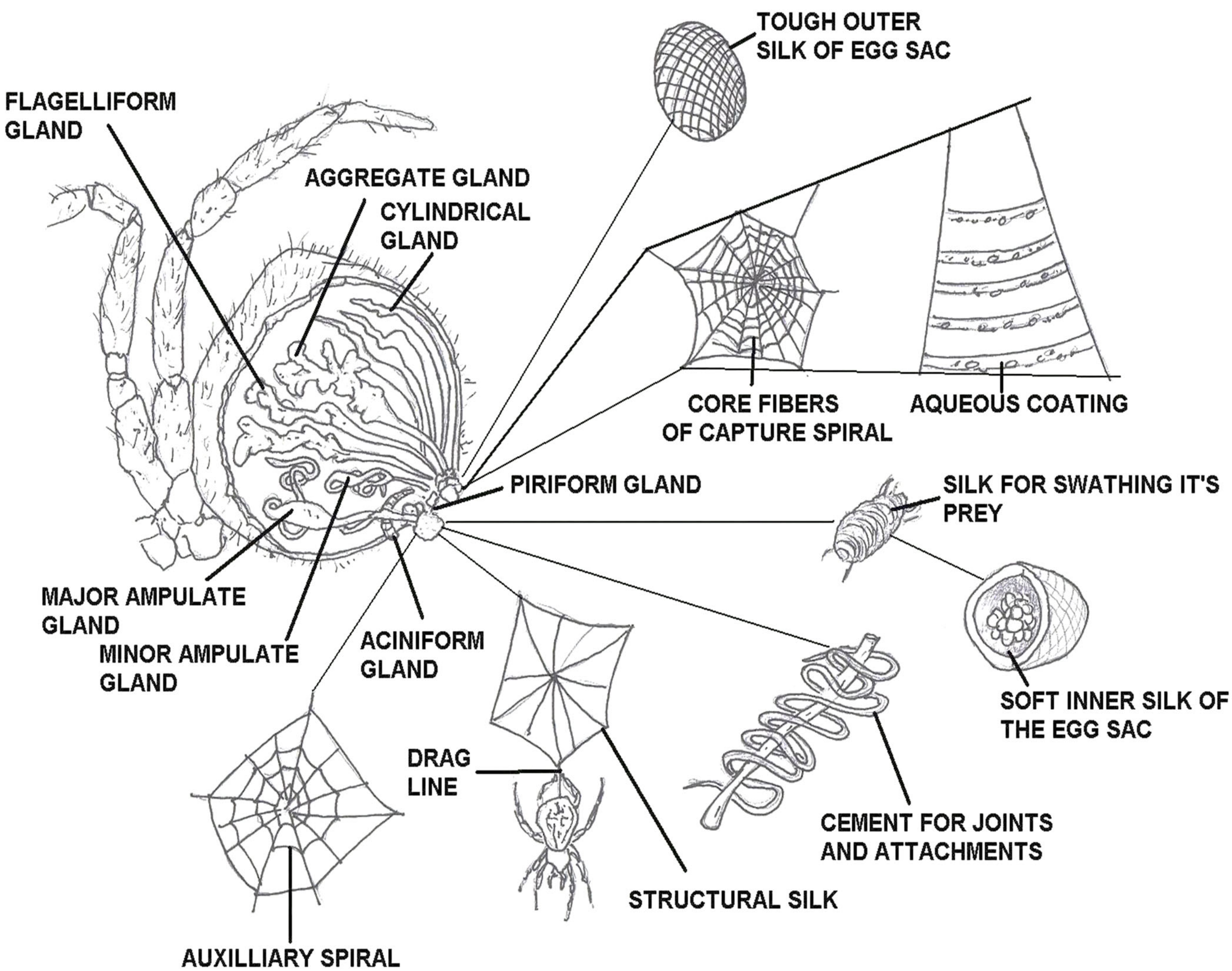
Other wasps called ichneumons will lay a single egg on a spider and the wasp larva that hatches then slowly eats the spider alive. Still other insects are parasites or predators of spiders in all life stages. Mantidflies in the family Mantispidae develop as larvae inside a spider egg sac, eating all the spider's eggs. Even human beings eat spiders intentionally. Some native peoples in South America hunt giant tarantulas and fry them. The spiders are considered a crunchy delicacy. Other mammals, like shrews, coatimundi, meerkats, and grasshopper mice also eat spiders regularly. So do reptiles, especially lizards. Birds not only eat spiders, but will use spider silk in making their nests.

Spiders get into your homes in one of two ways: 1) because you brought them in (firewood, boxes, stored materials, etc.) or 2) because they are attracted to the prey insects living in and around your house and found a way in. You can prevent them from coming in by weather stripping doors, repairing screens, and caulking and control prey insect populations. Insecticidal treatments are not recommended for controlling spiders.

Many types of spiders prefer living in houses and these species are generally not harmful to humans. Various kinds of small hunting spiders may wander indoors and occasionally, rather large, hunting-type spiders are discovered in homes or garages. Often these are fully grown wolf spider or tarantula males that have reached maturity and are searching for females. When these spiders are wandering, one or more may accidentally get indoors. The more insects there are inside a building, the more likely it is to have spiders living there.

When working in potentially spider-infested areas or handling firewood, always wear gloves and a long-sleeved shirt. When working in crawlspaces or attics wear a hooded sweatshirt and tuck your pants into your socks. If you suspect you have been bitten, try to safely capture the spider for identification (I know what you are thinking and yes, a smashed sample is better than nothing). Finding the spider is helpful in diagnosing and treating the bite and may aid physicians in diagnosis and treatment of spider bites (especially brown spider bites).

Bites from blood-feeding insects (kissing bugs, bird bugs, and bedbugs) can be mistaken for spider bites. In addition, environmental conditions, reactions to chemicals in the environment (pesticides, cleaning products, etc.), and other underlying health conditions can be misdiagnosed as spider or insect bites. It is best to learn to respect, tolerate, and enjoy spiders - they are excellent pest controllers in your garden, landscape and home.



SPIDER WEB COMPONENT DIAGRAM #3

Spider Prevention and Non-Chemical Control
Spiders may enter houses and other structures through cracks and other openings. They also may be carried in on items like plants, firewood, and boxes. Regular vacuuming or sweeping of windows, corners of rooms, storage areas, basements, and other seldom used areas helps remove spiders and their webs. Vacuuming spiders can be an effective control technique because their soft bodies usually do not survive this process. Indoors, a web on which dust has gathered is an old web that is no longer being used by a spider.

Individual spiders can also be removed from indoor areas by placing a jar over them and slipping a piece of paper under the jar that then seals off the opening of the jar when it is lifted up. To prevent spiders from coming indoors, seal cracks in the foundation and other parts of the structure and gaps around windows and doors. Good screening not only will keep out many spiders but also will discourage them by keeping out insects that they must have for food.

In indoor storage areas, place boxes off the floor and away from walls, whenever possible, to help reduce their usefulness as a harborage for spiders. Sealing the boxes with tape will prevent spiders from taking up residence within. Clean up clutter in garages, sheds, basements, and other storage areas. Be sure to wear gloves to avoid accidental bites.

Outdoors, eliminate places for spiders to hide and build their webs by keeping the area next to the foundation free of trash, leaf litter, heavy vegetation, and other accumulations of materials. Trimming plant growth away from the house and other structures will discourage spiders from first taking up residence near the structure and then moving indoors.

Outdoor lighting attracts insects, which in turn attracts spiders. If possible, keep lighting fixtures off structures and away from windows and doorways. Sweep, mop, hose, or vacuum webs and spiders off buildings regularly. Insecticides will not provide long-term control and should not generally be used against spiders outdoors.

Chemical Control
Typically pesticide control of spiders is difficult unless you actually see the spider and are able to spray it. There are various insecticides available in retail outlets labeled for spider control, including pyrethrins, resmethrin, allethrin, or combinations of these products. If you spray a spider, it will be killed only if the spray lands directly on it; the spray residual does not have a long-lasting effect. This means a spider can walk over a sprayed surface a few days (and in many cases, a few hours) after treatment and not be affected.

Control by spraying is only temporary unless accompanied by housekeeping. It is just as easy and much less toxic to crush the spider with a rolled up newspaper or your shoe or to vacuum it up. Sticky traps offer a non-insecticidal way to remove spiders from your home as long as you can place the traps where pets and curious children can’t tamper with them.

Sorptive dusts containing amorphous silica gel (silica aerogel) and pyrethrins, which can be applied by professional pest control applicators only, may be useful in certain indoor situations. Particles of the dust affect the outer covering of spiders (and also insects) that have crawled over a treated surface, causing them to dry out.

When applied as a dustlike film and left in place, a sorptive dust provides permanent protection against spiders. The dust is most advantageously used in cracks and crevices and in attics, wall voids, and other enclosed or unused places.

When is a Spider Web not a Spider Web?

There is a species of moth that makes an awesome spider web. These moths are harmless but scare people all over the world in to thinking spiders have gone crazy. Certain members of the unrelated snout moths (Pyralidae) are also known as "***ermine moths***".

Yponomeutidae
The family Yponomeutidae is known as the ermine moths, with several hundred species, most of them in the tropics. The larvae tend to form communal webs, and some are minor pests in agriculture, forestry, and horticulture. Some of the adults are very attractive. Adult moths are minor pollinators.

There are five or six subfamilies:

- Argyresthiinae
- Attevinae
- Praydinae
- Saridoscelinae
- Scythropiinae (sometimes in Yponomeutinae)
- Yponomeutinae

Species include:

- Ailanthus webworm, Atteva aurea
- Apple Ermine Yponomeuta malinellus
- Bird-cherry Ermine, Yponomeuta evonymellus.
- Orchard Ermine, Yponomeuta padellus.
- Spindle Ermine, Yponomeuta cagnagellus.
- Yponomeuta plumbella.

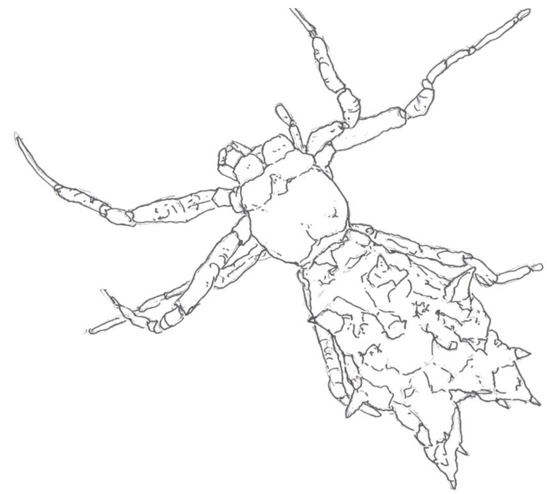
ERMINE MOTH

The buff ermine (Spilosoma lutea) is a hairy moth of the family Arctiidae. It's called buff ermine because of its buff coloring. Its color varies from yellowish to creamy with some black spots. Generally male are yellowish and females are creamy.

Spider History

One theory is that our friends the spiders evolved million years ago. Those ancient spiders were relatively large, and their bodies were segmented. In contrast, almost all spiders living today have an unsegmented abdomen. Only members of the suborder Mesothelae still exhibit a segmented abdomen, and these spiders are generally considered the most primitive types of spiders.

The fossil record of spiders is rather limited. The oldest spider fossil was found in New York State, in rocks dating back to the Devonian Period (about 410 million to 360 million years ago in theory). This fossil was remarkably well preserved. Using a microscope, scientists were able to recognize the spider's spinnerets and chelicerae. Some fossil spiders with segmented abdomens have been identified in rocks dating from the Carboniferous Period (360 million to 290 million years ago). Very few fossils have been found from the Mesozoic Era (240 million to 65 million years ago). These dates are all theories.



MICRATHENA GRACILIS

Spider webs rarely preserve as fossils, but scientists theorize that ancient spiders initially built irregular webs located near the ground, and that webs located higher up in trees evolved only later. Orb webs, for instance, may be an adaptation for snaring insects flying higher up in the vegetation. Some scientists suggest that spiders may have influenced the evolution of insects—and vice versa. In an effort to escape ground-living spiders, insects may have evolved ways to fly. At a later time, spiders may have learned ways to develop aerial webs in order to catch flying insects.

Mythology of Spiders

Arachne was a beautiful mortal with an exquisite talent for weaving. So gorgeous was her work that it was often said she could be an intern to Athena, or possibly weave better than the goddess of weaving. Athena became aware and instantly jealous of Arachne for two reasons. No one should be compared to a goddess in skill, and secondly, her husband, Zeus, had also noticed Arachne and was, like many powerful deities, prone to a soft spot (or hard spot as the case may be) for interns.

Athena visited Arachne, disguised as an old woman, to find out the truth. Arachne boasted of being able to out-weave the goddess and of the attention given to her by Zeus. Athena shed her disguise and challenged Arachne to a weaving contest. It was never discovered who won, as half way through, Athena touched Arachne's forehead and made her feel remorse for everything wrong she had ever done wrong.

It was too much for her poor human brain, and Arachne killed herself. Athena had not anticipated this and felt bad. She brought Arachne back to life, but not as a human, but as a hideous, eight legged spider, doomed to repel men, terrify women, and whose offspring were doomed to weave for eternity (obviously Athena did not feel all that bad).

Deadly Spider's Venom may Yield Super Virility
Chile's black widow also has promising spermicidal abilities, scientists find

Reuters SANTIAGO, Chile - Scientists have discovered a potentially marketable contraceptive in the venom of Chile's black widow spider, whose bite is fatal to many but can also cause prolonged, painful and involuntary erections in men. The venom of the Latrodectus mactans, a variety of black widow found only in the south of Chile, has spermicidal properties not found in black widows in other regions of the world, Chilean Dr. Fernando Romero said.

Romero heads a research team that has studied the spider's venom for seven years, prompted by tales of Chilean farmers who acquired superhuman virility after being bitten by the black widow.

Initial studies focused on taking extracts from the venom to treat erectile dysfunction, but they soon discovered it had a molecule that also made it an effective contraceptive. "This is a great business opportunity, we are the creators of the spermicide," Romero told Reuters by telephone. He said he believes the molecule's natural properties are superior to those of synthetic spermicides currently on the market.

"For us in Chile, this has opened a window of opportunity to an incredible market, since currently there are no naturally based spermicides that have the properties of this discovered molecule," Romero said. Romero, based at the Universidad de la Frontera in the southern city of Temuco, has already applied for a patent for his erectile dysfunction medicine. 'Spider-bitten.' His team discovered the property after looking into Chilean folklore that describes a virile man, one known to have spectacular sexual energy or many sexual partners, as being "spider-bitten."

The Chilean black widow is also known as the wheat spider for the wheat fields it inhabits and where its farmer-victims receive their often fatal bite.

The spider's bite can kill children and the elderly, but among strong young farmers it leads to erections that can last for days and involve involuntary ejaculations. At the end of the ordeal, the man is left sexually energized and feels physically stronger, the saying goes.

Short and sweet comment, if your wife places spiders in your lunch box, she may be trying to tell you something.

Arachnid Introduction Post Quiz

Fill-in-the blank

1. There are eleven orders of arachnids. These include the scorpions; mites and ticks; harvestmen; pseudoscorpions; whipscorpions; solpugids; and spiders. It's like the relation of beetles with insects: beetles constitute one order of insects, the______________, but not all insects are beetles. Similarly, not all arachnids are spiders.

Spider's Life
Biology

2. Spiders range in size from less than 1.0 mm (0.04 in) to more than 10 cm (4 in) in length, with a leg span of up to 20 cm (8 in). A spider's body is divided into two parts: the front portion, called the___________, and the rear portion, called the opisthosoma or abdomen. A narrow stalk called the pedicel connects these two parts.

Spider Reproduction

3. All species of spiders have two separate sexes, and the males are usually smaller than the females. The male spider has two sperm-producing testes. A sexually mature male spider uses _________to transfer sperm cells into the female during mating. In this process, the male builds a small, triangular sperm web, onto which he deposits a drop of sperm from his abdomen. He then dips both palps into this droplet, drawing sperm cells into the palps as if by a tiny pipette.

Types of Spider Webs

4. Web patterns vary considerably, depending on the species of spider. Perhaps the most recognizable web is the almost___________, in which an outer framework supports a continuous spiraling thread and a series of threads radiating from the center of the web. Other web types may have a more irregular shape. Some spiders build irregular, flimsy webs.

Constructing an Orb Web

5. Once the web is completed, the spider will chew of the ___________then sit and wait for its prey. During construction, if the web becomes broken but without structural damage, the spider will not initially attempt to fix the problem. After having made the web, the spider will wait on or near the web for its prey to fall victim to its sticky trap. Once its prey has become trapped, the spider will initially feel the vibrations from the impact and then the struggle.

6. Spiders do not normally stick to their own webs thou they are not immune to sticking to them. When moving around there webs they must be careful so not to get stuck by using ___________in there webs.

7. A spider that positions its self at the center of the web is very visible to predators such as birds; many orb web spiders that hunt during the day will reduce this risk by hiding at the edge of its web, with one foot on a ________________from the center of the web.

8. Many types of spiders prefer living in houses and these species are ________to humans.

Spider Prevention and Non-Chemical Control

9. ________________can be an effective control technique because their soft bodies usually do not survive this process.

10. To prevent spiders from coming indoors, seal cracks in the foundation and other parts of the structure and gaps around windows and doors. Good ___________not only will keep out many spiders but also will discourage them by keeping out insects that they must have for food.

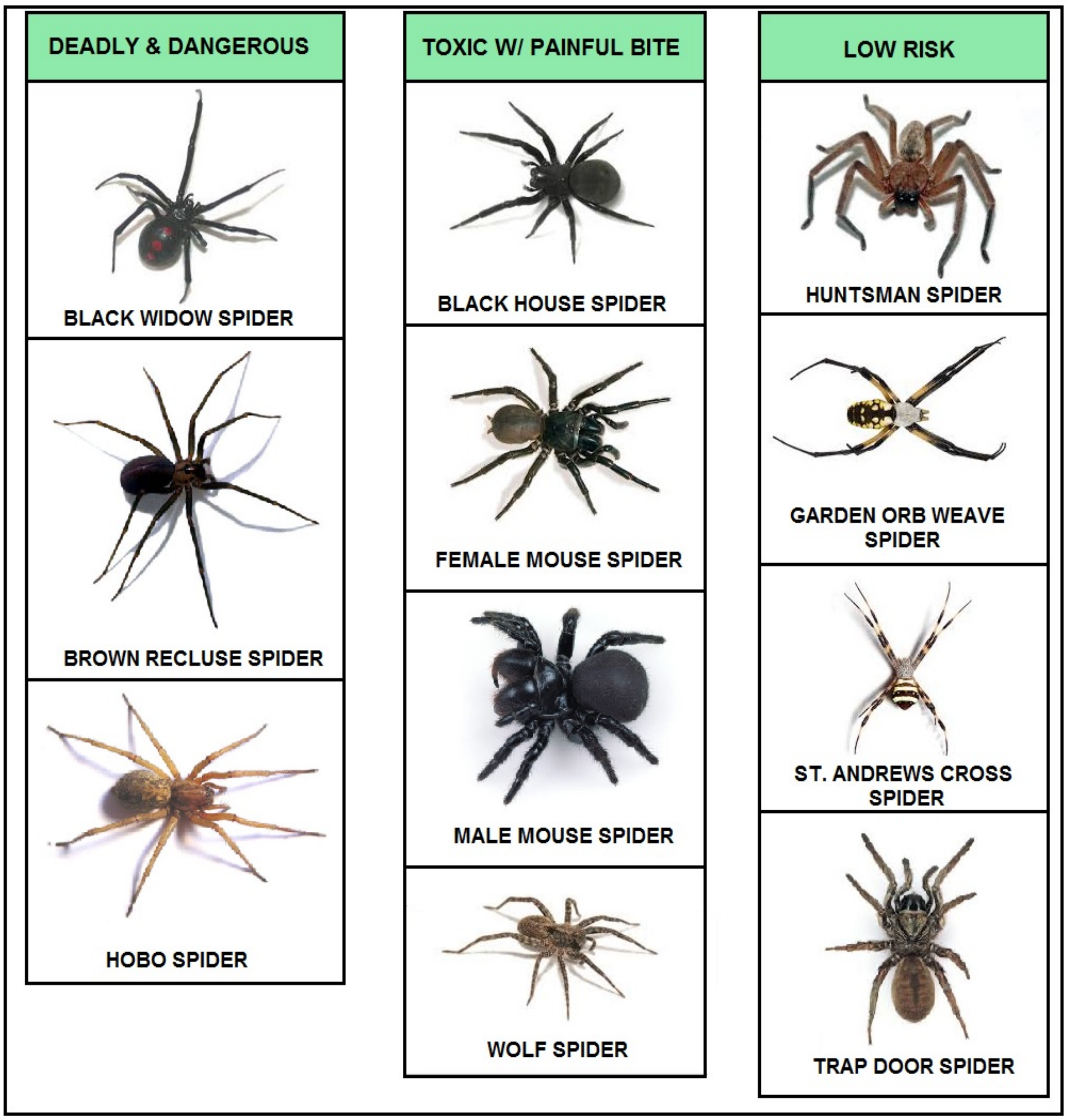
Arachnid Introduction Post Quiz Answers

1. Coleoptera, 2. Prosoma or cephalothorax, 3. Its large palps, 4. Circular orb web, 5. Initial three center spiral threads, 6. Non-sticky threads, 7. Signal line, 8. Generally not harmful, 9. Vacuuming spiders, 10. Screening

Topic 10 - Spider Identification Section

Section Focus: You will learn the basics of spider identification. At the end of this section, you will be able to understand and describe various spiders. You will learn about common US spiders, genera, life cycle and related subjects. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Spiders can be divided into one of two groups depending on how they capture their prey: hunting (sometimes known as wandering) spiders and web-building spiders



COMMON US SPIDER DIAGRAM

Two Primary Spider Groups
Spiders can be divided into one of two groups depending on how they capture their prey: hunting (sometimes known as wandering) spiders and web-building spiders. All spiders produce silk, but hunting spiders do not construct webs to capture food. Instead, they rely on their quickness and relatively good eyesight to capture prey. Web-building spiders construct webs in rather quiet, undisturbed places to capture their food. They live in or near their web and wait for food to come to them. They generally have poor eyesight and rely on sensing vibrations in their web to detect prey.

Hunting Spiders
Crab Spiders
Are common spiders outdoors, but are not usually seen indoors. They are small to medium-sized spiders (1/10 - 2/5 inch long) ranging in color from yellow or red to brown or gray. The first four legs of crab spiders are crab-like, being held out to the sides. They are also usually longer than the back four. Crab spiders can walk forwards, sideways, or backwards. While many hunting spiders actively pursue prey, crab spiders wait motionless and ambush insects that pass closely by. Outdoors, crab spiders are often found on flowers but are also seen on stems or leaves.

Fishing Spiders – Human Biters
Also known as dock spiders, are typically seen around ponds, swamps, slow-moving streams, and nearby vegetation. They may occasionally be found indoors. Fishing spiders are the largest spiders in the Upper Midwest (1 inch long). With legs spread out, some fishing spiders cover as much as 4 inches. They are generally dark-colored, usually brownish or grayish, with white markings. Fishing spiders can "skate" across water and can dive underneath to capture prey. In addition to insects, fishing spiders can also catch tadpoles, small fish, and other small vertebrate animals.

Gnaphosid Spiders
Are commonly found outdoors. A specific gnaphosid spider known as a parson spider is occasionally seen inside. The parson spider is a medium-sized spider (1/2 inch long) with a brownish body and gray abdomen with a white band running down over half the length of its abdomen. Parson spiders hunt at night. During the day, they are usually found outdoors under stones or loose bark in silken retreats. Indoors, they hide under objects or in cracks or crevices.

Huntsman Spiders
Venom toxicity - the bite of Huntsman Spiders is of low risk (non-toxic) to humans. They are a non-aggressive group of spiders. However, a large individual can give a painful bite. Beware in summer when the female Huntsman Spider is guarding her egg sacs or young.

Spider Identification - an adult varies greatly around 1/2" in body length - has long legs - the diameter of an adult including legs may reach 2" - the first 2 pairs of legs are longer than rear two - it is hairy - buff to beige brown in color, with dark patches on the body.

Habitat - a hunter that prefers to live under the flaking bark of trees, under flat rocks and under eaves or within roof spaces of buildings. The Huntsman Spider often wanders into homes and is found perched on a wall. It is a shy, timid spider that can move sideways at lightning-fast speed when disturbed.

Jumping Spiders
Are common spiders outdoors and indoors. They are active during the day and are often found around windows, ceilings, walls, and other areas exposed to sunlight. Jumping spiders are generally small to medium-sized (about 1/5 - 1/2 inch long) and compact-looking. They are usually dark-colored with white markings, although some can be brightly colored, including some with iridescent mouthparts.

These spiders move quickly in a jerky, irregular gait. They get their name from their ability to leap on their prey, often jumping many times their own body length. Like most spiders, jumping spiders have eight eyes, of which the two middle eyes are particularly large. Jumping spiders have the best vision of spiders, seeing objects up to 8 inches away.

Jumping spiders (Family Salticidae) get their name from the sometimes spectacular leaps they make when pouncing on prey or simply hopping about in the foliage. They are very small to medium sized spiders 3-15mm (1/8 -- 5/8") long. Their eight eyes are arranged in 3 rows - the first row near the midline contains the largest pair, which faces forward in the manner of predatory animals requiring binocular vision, and a second, smaller pair outboard of those, also facing forward and slightly upward. The second row of eyes is very much smaller and facing upwards and only slightly forward. The jumping spiders have the most acute eyesight of all spiders.

Mouse Spiders – Human Biter
Venom toxicity - known to cause severe illness, especially to young children - similar to Red-Back Spider. Although normally not aggressive, the male mouse spider will bite if provoked, and should be considered dangerous to humans. It has large hard fangs which can cause a deep painful bite. First aid and medical attention (ambulance) should be sought as soon as possible.

Spider Identification - a medium to large spider of up to 1 and 1/2 inches in body length. The male Mouse Spider often has a bright red head and elongated fangs.

Habitat - Mouse spiders are ground dwellers with burrows of more than 3 feet deep. The male often wanders about during the day on open ground, especially after rain, in search of females.

Purseweb Spiders (Sphodros genus, Atypidae family, Mygalomorphae suborder)
Mygalomorphs are generally large spiders; though they seem to be the species most likely to inspire arachnophobia, all of the US species are harmless to humans. True Tarantulas (family Theraphosidae) are members of this suborder; some are found in the Southwestern US. The Atypidae are sometimes known as "atypical tarantulas." There are two genera in the US: Atypus and Sphodros

Sac Spiders
Also known as two-clawed hunting spiders are common spiders on foliage or on the ground, and can be commonly found indoors. They are small to medium-sized spiders (1/5 - 2/5 inch long) and are usually yellowish or light-colored. Although sac spiders do not construct webs, they do build retreats from silk. Outdoors, they usually roll up leaves into a tube, or may construct a retreat under stones. Inside buildings, sac spiders are found in retreats in a variety of places, including high up on walls near ceilings.

Wandering Spiders

Some spiders will enter buildings in search of food and shelter, particularly in the fall when the temperatures become cooler. Below is a list of spiders that are often found in or around buildings. Although many spiders can bite, the injury from this group is usually similar to a bee sting.

Wolf Spiders

Are common spiders outdoors and are occasionally seen indoors. They are moderate to large-sized spiders (1/4 - 3/4 inch long). Wolf spiders are found on the ground or under stones in a wide variety of habitats, such as forest floors, grassy meadows, swamps, and bogs. Some even like to live underground. They commonly hunt during the day or at night when it is warm. Wolf spiders are dark-colored, usually brownish or grayish, with white markings.

Ground Spider Sub-Section

Tarantula

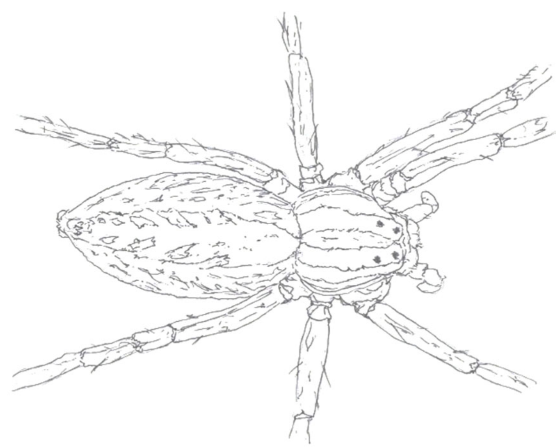
True tarantulas are a type of wolf spider that belong to the family Lycosidae in the suborder Araneomorphae. However, most people use the term *tarantula* to refer to about 700 species of spiders belonging to the family Theraphosidae in the suborder Mygalomorphae.

Sometimes known as American tarantulas, they are found in tropical regions throughout the world, with many species in the southwestern United States. These giants of the spider world can attain a body length of 10 cm (4 in) with a leg span up to 20 cm (8 in), making it possible for some species to overpower small vertebrates (animals with backbones), such as frogs or lizards, for their meal. Their large body and long legs are covered with hairs, and they have powerful chelicerae, giving them a fearsome appearance. Most tarantulas stay on the ground (often in burrows). As ground hunters, tarantulas are typical sit-and-wait predators—they wait for insects or small vertebrates to come near before they pounce and kill the prey with their strong chelicerae.

Perhaps as a result of their frightening size and appearance, tarantulas have gained a deadly reputation among humans. For the most part, however, tarantulas do not attack unless provoked, and their venom is not harmful to humans, although their strong chelicerae can cause painful wounds. Tarantulas are popular pets, and some become so tame that they can be picked up and handled safely. Although the chance of receiving a bite is small, there is another danger: Many tarantulas brush off their abdominal hairs when they feel threatened. These barbed hairs fly through the air and can penetrate skin and the mucous membranes of the nose, causing a strong burning sensation.

Wolf Spider

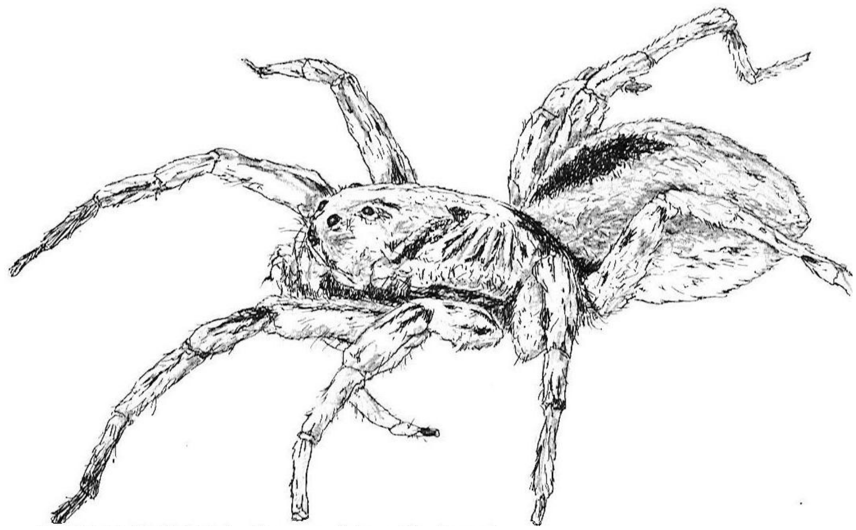
About 2,000 species of wolf spiders belong to the family Lycosidae in the suborder Araneomorphae. Found throughout the world, these spiders have dull brown or black coloration, stout bodies, and long, thick legs. Some species have hairy bodies.



RABID WOLF SPIDER

Wolf spiders are ground hunters, but their name inaccurately suggests that they actively hunt their prey just like their wolf namesake. However, like tarantulas, most wolf spiders usually sit in a hidden spot. When prey happens by, they ambush the prey by jumping on it. Wolf spiders are sensitive to vibrations, such as the buzzing wings of insects, as well as to visual signals.

For instance, during courtship males drum their legs on the ground or wave their legs and palps in a rhythmic dance in order to catch a female’s attention. Female wolf spiders are renowned for their brood care. After laying eggs, a female spider carries the cocoon attached to her spinnerets. When the spiderlings hatch, she allows them to ride on her back for about a week. Some larger wolf spiders dig burrows in the soil, which they may line with silk and provide with a door. At night they leave their burrows to hunt for insects.



WOLF SPIDER (LYCOSDAE GULOSA)

Biology: Wolf spiders occupy a variety of ecological niches, including most terrestrial habitats. Some species are amphibious, having the ability to skate on the surface of water. Other species are diggers that build burrows in sandy soil. Wolf spiders are most numerous in grasslands where crickets and grasshoppers abound. These spiders capture prey by pouncing on and holding it while several bites are delivered with the chelicerae. They have a higher visual acuity than most spiders and use vision to locate and track prey.

Nocturnal species have reflective surfaces behind the retina that double the stimulation from a given unit of light and also cause the eyes to glow brightly in a flashlight beam. Although there are considerable variations in life histories, all female wolf spiders have a common and fascinating set of maternal care behaviors. After mating, a female produces a carefully constructed silken sac, into which she lays her eggs. She then attaches the egg sac to her posterior at her spinnerets and carries it with her wherever she goes, until the young spiderlings have hatched.

After hatching, the mother opens the sac with her chelicerae, and the young quickly escape and climb on their mother's back, where they remain until ready to molt and take up independent lives.

Envenomation: Although some tropical wolf spider species are suspected of having venoms that produce serious pathology in humans, the bite of most species causes only very mild symptoms.

Treatment: Wash the bite site with soap and water, and then treat with an antiseptic. Consult a physician if any unusual symptoms or infection should occur.

Precautions and Control: Don't handle wolf spiders. If one is found in a house, it should be "herded" to an exit. Wolf spiders generally move too rapidly to be swept up in a dustpan or otherwise captured. No control method is recommended for these spiders. They should be considered beneficial.

Tarantula Hawk Wasp

The tarantula hawk is the common name for species in the genera Pepsis and Hemipepsis of the family Pompilidae, in the insect order Hymenoptera. These two genera are limited to the Western Hemisphere, and “tarantula hawks” in the Eastern Hemisphere belong to different genera. These genera of wasps are called tarantula hawks due to their hunting of tarantulas as food for their larvae.

TARANTULA HAWK

Tarantula hawks are up to two inches (50 mm) long with a blue-black body and bright rust-colored wings. The bright rust coloring that they have on their wings is also known as aposematic coloring; this warns potential predators that they are dangerous. Their long legs end with hooked claws for grappling with their victims. The stinger of a female tarantula hawk can be up to 1/3 inch (7 mm) long.

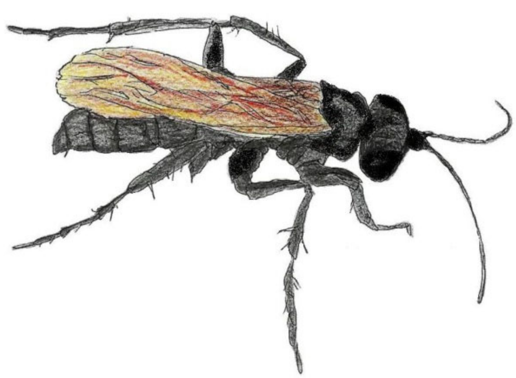
Female tarantula hawks may hunt for wandering male tarantulas. However, during the insect's reproductive season, male tarantulas are usually emaciated from ignoring food while searching for females. The tarantula hawks prefer female tarantulas and seek them in their burrows. They capture (often following a dramatic battle), sting, and paralyze the spider. Next they either drag the spider back into her own burrow or transport their prey to a specially prepared nest where a single egg is laid on the spider’s body, and the entrance is covered.

The wasp larva, upon hatching, begins to suck the juices from the still-living spider. After the larva grows a bit, the spider dies and the larva plunges into the spider's body and feeds voraciously, avoiding vital organs for as long as possible to keep it fresh. The adult wasp emerges from the nest to continue the life cycle. Tarantula hawks are "nectarivorous." The consumption of fermented fruit sometimes intoxicates them to the point that flight becomes difficult. While the wasps tend to be most active in daytime during summer months, they tend to avoid the very highest temperatures. The male tarantula hawk has an interesting behavior: many act in a behavior called "hill-topping," where they sit on top of tall plants and look out for females who are ready to reproduce.

TARANTULA HAWK'S STINGER

These wasps are usually not aggressive, but the sting, particularly of Pepsis formosa, is among the most painful of any insect. Commenting on his own experience, one researcher described the pain as "...immediate, excruciating pain that simply shuts down one's ability to do anything, except, perhaps, scream." Mental discipline simply does not work in these situations." It is listed near the top of the list in Schmidt Sting Pain Index. Although the sting is quite painful, the effect is reported to last only a few minutes and is fatal less often than the honey bee. Because of their stingers, very few animals are able to eat them; one of the few animals that can is the roadrunner.

What is a Wasp?
A wasp is any insect of the order Hymenoptera and suborder Apocrita that is not a bee or ant. The suborder Symphyta includes the sawflies and wood wasps, which differ from members of Apocrita by having a broader connection between the mesosoma and metasoma. In addition to this, Symphyta larvae are mostly herbivorous and "caterpillar-like", whereas those of Apocrita are largely predatory or "parasitic" (technically known as parasitoid).



SPIDER WASP

Black Widow Spider Sub-Section
Araneae: *Theridiidae, Latrodectus mactans*


BLACK WIDOW **BROWN RECLUSE**

Brown Widow Spider
Looks like a Bowl and Dolly or a caramel colored Black Widow Spider. It is rare but can be found in Southern California around Fontana, Riverside and areas of trucking containers are stored. I treat these dudes the same as any orb spider. It is not a brown recluse which is very rare in California, you will most likely find a Desert Recluse, but the recluse doesn't look anything like a black or brown widow female spider, maybe a huge male black widow at best. Women will generally call all spiders brown recluses or black widows.

Black Widow Spider
The male black widow's abdomen is more elongated than that of the female, with white and red markings on its sides. The female's abdomen is almost spherical, usually with a red hourglass mark below or with 2 transverse red marks separated by black. The legs of the male are much longer in proportion to his body than those of the female. The female is more easily recognized, her shiny black body giving great contrast to the red hourglass marking on her round abdomen.

The black widow's range is from Massachusetts to Florida and west to California, Texas, Oklahoma and Kansas. Although they can be found in almost every state (and some portions of Canada), this spider is most common in the Southern locales of the United States. Black widow spiders are common around wood piles, and are frequently encountered when homeowners carry firewood into the house. Also found under eaves, in boxes, underneath unused construction materials, inside wooden toy boxes, firewood boxes, outdoor toilets, meter boxes, and other unbothered places.

The female black widow spider rarely leaves her web. The web she constructs is an irregular, tangled, crisscross web of rather coarse silk.

The core of the web is almost funnel shaped, woven into a silken tunnel in which the female spider spends the majority of her daylight hours. This web is altered and rebuilt on a regular basis and is capable of capturing rather large insects. The female wraps any captured prey with her silk, repeatedly turning her victim with her legs as she applies more silk.

After her victim is covered in silk, the spider kills her prey by injecting her venom. The prey might be eaten immediately or reserved for a later feeding. After the prey is fed upon and the body fluids are sucked from the victim, the carcass is cut loose and allowed to drop to the ground. The female black widow is most often found hanging upside down in her web, where she spends most of her daytime hours. She stays close to her egg mass, defensively biting anything that disturbs her or her egg sac. After laying her eggs, the female black widow is hungry and more likely to bite a human. The female black widow stores sperm, producing more egg sacs without mating. Some females live more than three years, with older females dying in autumn after egg laying.

Egg Sacs
Egg sacs are pear shaped (or oval); brown, papery, and about ½ inch long. They hold from 25 to 900 or more eggs, which have an incubation period of 20 days. The spiderlings disperse shortly after emerging, tearing an opening in the egg sac but staying near the sac. After several hours, these second instar spiderlings balloon to the ground and scatter. Growth requires two to three months. Of all spiders, the Black Widow is the most feared. The female's venom is especially poisonous to people. Despite its reputation, this spider often attempts to escape rather than bite, unless it is guarding an egg mass or if it is cornered and pressed.

The male black widow will not bite you. After mating, the female sometimes eats the male (remember, she only has to mate once in her life), earning the name "widow." During the period shortly following mating and laying of eggs, the female black widow can be a little cranky and hungry. After this period (if he lives through it!) the male lives quite comfortably, eating prey captured by the female. The development of his venom sacs stop and become inactive as the male matures, thus making him less of a potential problem than his female counterpart.

Bite
The bite of the female black widow spider may not always be felt at first, and besides slight local swelling; there is usually little evidence of a lesion. Two tiny red spots can sometimes be observed in the center of the swollen area. Most of the time, pain at the site of the bite occurs immediately and becomes most intense after about three hours.

An overall aching of the body, especially the legs, is a common reaction. Headache, elevated blood pressure, nausea and profuse perspiration may occur in severe cases. The condition is self-limiting and in most cases symptoms disappear in two or three days. Calcium gluconate is used intravenously to relieve and relax muscle spasms produced by black widow venom.

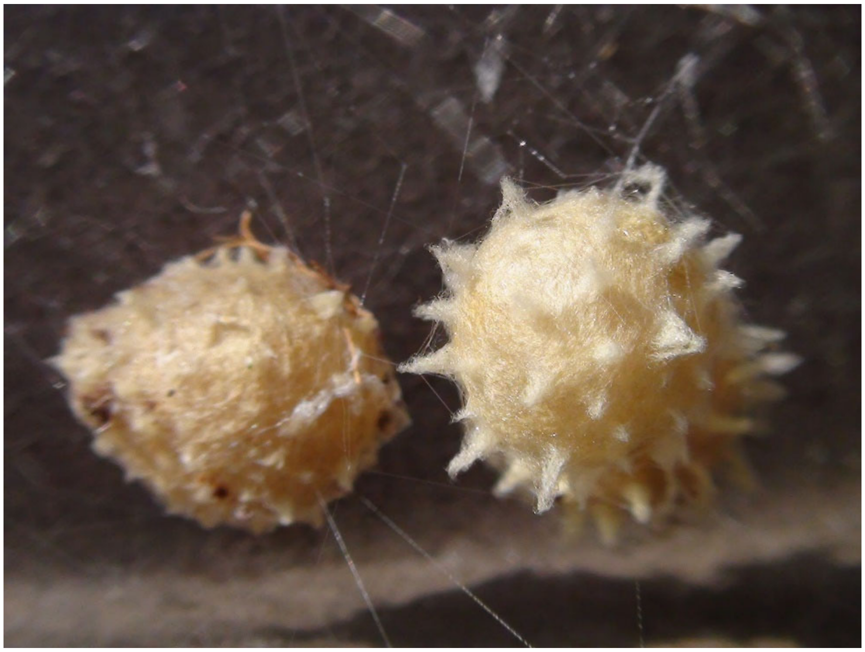
Be very careful when working around areas where black widow spiders may be established. Take proper precautions, wear gloves, and pay attention to where you are working. Black widow bites are sharp and painful, and the victim should go to the doctor immediately for treatment. Seek medical attention if you think you have a spider bite. If possible, collect up the spider or what remains of it and take with you to your doctor or emergency clinic.

Brown Window Spider Sub-Section

FEMALE BROWN WIDOW SPIDER (LATRODECTUS GEOMETRICUS)

The brown widow spider (Latrodectus geometricus) is native to South Africa and was first discovered in the United States in 1935. This spider is also commonly known as the grey widow, brown button and geometric button spider. While it is true that brown widow spiders are highly venomous to their prey, they are very timid and rarely bite humans; when they do bite, they don't inject all their venom making them less harmful.

The brown widow is a medium to large spider that is slightly smaller than its cousin, the black widow. Its coloration ranges, but it is usually either dark grey, brown, or black. There is a general striped pattern on the legs and dorsal (top) side, and brown mottling on the ventral (bottom) side. Like the black widow, it often has an hourglass figure on its abdomen. However, instead of this marking being red, it is usually a vivid orange or yellowish.



BROWN WIDOW EGG SAC

If you cannot identify this spider by its markings alone, another method is to look for its distinctive egg sac. This spider floats its egg sac in a network of webs. The sac resembles a sandspur, having brown coloration and pointed projections on its surface. The egg sacs are often described as being "tufted," "fluffy," or "spiky" in appearance.

American Recluse Spider Sub-Section

Eleven species of recluse spiders are native to the United States, and a few non-natives have become established in circumscribed areas of the country. The brown recluse spider is the proper common name for only one species, Loxosceles reclusa. It is the most widespread of the North American recluse spiders and lives in the south central Midwest from Nebraska to Ohio and south through Texas to Georgia.

BROWN RECLUSE SPIDER UNDERSIDE CLOSE-UP

Although the brown recluse does not live in California, they do have four species of native recluse spiders. The most common Californian recluse spider is the desert recluse, L. deserta. It is found mostly in the Sonoran and Mojave deserts, in the foothills of the lower San Joaquin Valley, and in adjacent areas of Mexico, all of which are sparsely populated by humans. In older literature, this spider was referred to as L. unicolor.

There are additional species (L. russelli, L. palma, L. martha), but they are so uncommon that they are of scientific interest only.

In addition to these native species, a South American recluse spider, Loxosceles laeta (pronounced "LEE-ta"), has become established in portions of Los Angeles (Alhambra, Sierra Madre, Monterey Park). This spider, however, seems to be confined to a very limited area in Los Angeles County, even though it has lived there for over 30 years. Also, occasional interceptions of the Mediterranean recluse, L. rufescens, are found in commercial goods shipped from out-of-state, but no populations of this spider have been found in California.

BROWN RECLUSE EGG SAC

BLACK WIDOW WITH EGG SAC AND MALE BLACK WIDOW

Other Widow Spiders

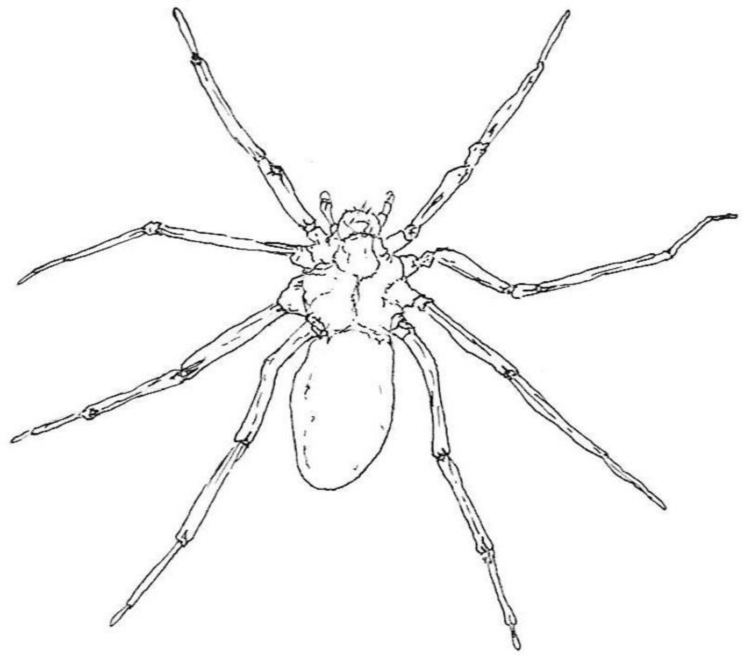
BROWN WIDOW FEMALE SPIDER

ORANGE WIDOW SPIDER

WHITE WIDOW SPIDER

RED WIDOW SPIDER

Brown Recluse Spider
Araneae: Loxascelidae, Loxosceles reclusa



BROWN RECLUSE (LOXASCELIDAE RECLUSA)

Over the years, the group of spiders to which the brown recluse belongs has been known by various colloquial names: "***violin***" spiders, "***fiddleback***" spiders, "***recluse***" spiders, and "***brown***" spiders. Recently the American Arachnological Society chose "recluse spiders" as the official common name for this group. The scientific name for the recluse spider group is ***Loxosceles*** (lox-SOS-a-leez). All known members of the group have a scientific name, and the more familiar members of this group also have a common name (e.g., brown recluse, desert recluse, Arizona recluse).

The spider is golden brown, with the fiddle being dark brown or black. This spider is not hairy and the fiddle pattern is often shiny. They are about 1/4 to 3/4-inch long. Members of this small family are known for their poisonous venom. They have six eyes in three pairs.

The most definitive physical feature of recluse spiders is their eyes: most spiders have eight eyes that typically are arranged in two rows of four, but recluse spiders have six equal-sized eyes arranged in three pairs, called dyads. There is a dyad at the front of the cephalothorax (the first main body part to which the legs attach) and another dyad on each side, further back.

Many publications refer to the violin on the dorsal surface of the cephalothorax as the most important diagnostic feature. Although this marking is fairly consistent in mature brown recluses and Texan recluses (*L. devia),* it can vary in intensity and sometimes fades in preservative, and it is very faint to nonexistent in several recluse species found in the southwestern United States (e.g., the desert recluse).

Therefore, checking the eye pattern will eliminate almost all suspect recluse spiders from consideration, whereas the presence or absence of the violin marking may lead to misidentifications.

In addition, the abdomens of all recluses are covered with fine hairs and are uniformly colored, although the coloration can vary from light tan to dark brown, depending on what they have eaten. There is never a coloration pattern on the abdomen. Finally, the legs are similarly covered with fine hairs, whereas many non-recluse spiders have stout spines on their legs.

Some spiders share each of these physical characteristics (six eyes in dyads, dark pattern near the eyes, uniformly colored abdomen with fine hairs, no spines on the legs); however, no non-recluse spider has all four characteristics. On this basis, more than 99% of the spiders found by Californians can be identified as something other than a recluse spider. If, however, you do find a recluse spider in California, it will most likely be the native desert recluse, *L. deserta.* To further identify *Loxosceles* spiders to species requires a high-power microscope and the skills of a spider expert (arachnologist).

The cephalothorax is rather flat above and has a conspicuous, lengthwise furrow in the midline at the rear third. Each foot has two claws. Many of the wolf spiders are similar in appearance and have similar markings as the brown recluse. They are large, robust, hairy, and therefore, they can be distinguished from the brown recluse.

Brown Recluse spiders spin small, irregular webs under bark, stones, or other secluded areas. Their venom is especially poisonous to people; those bitten often become ill and find that the wound does not heal quickly. Both male and female brown recluse spiders, as well as their spiderlings, are capable of injecting venom that may result in serious lesion formation or systemic reactions. The severity of the bite may vary. The symptoms may vary from no harm at all to a reaction that is quite severe. Usually, the brown recluse spider bite is not felt and the pain sets in from six to eight hours later. A typical bite area may resemble a pimple, pustule, or blister formation within six to 12 hours later. Mild to severe pain, accompanied by swelling, may occur during this interval.

The surrounding tissue begins to darken, is irregular in shape, and has sharply raised edges, resulting in a sunken area which may be several centimeters in diameter. Often there is a systemic reaction within 24-36 hours, characterized by restlessness, fever, chills, nausea, weakness, and joint pain. Where the bite occurs, there is often tissue death, and skin is sloughed off. In some severe cases, a wound may develop that lasts several months. In all cases, a physician should be notified. If at all possible, kill and take the spider to the physician for positive identification. Individual spiders can be crushed underfoot or sprayed with an aerosol spray.

Brown recluse spiders are found primarily in the Midwest. Many cases of bites are reported from Alabama, Florida, Georgia, Texas, Kansas, Missouri, and Oklahoma. They are suspected of being in other states as well. The edge of its range just reaches the tip of western Virginia, but it occurs rarely in this state. The Brown Recluse has adapted quite well to indoor habitats. They are commonly found in the storage areas of residences, including areas such as attics, closets, bedrooms and other dark recesses. This spider frequently inhabits clothing, toys, books, boxes, and furniture, as well as transport trucks, tool sheds, tree houses, and little-used or abandoned dog houses. Bites often occur when the spiders hide in towels or old clothes left in those areas.

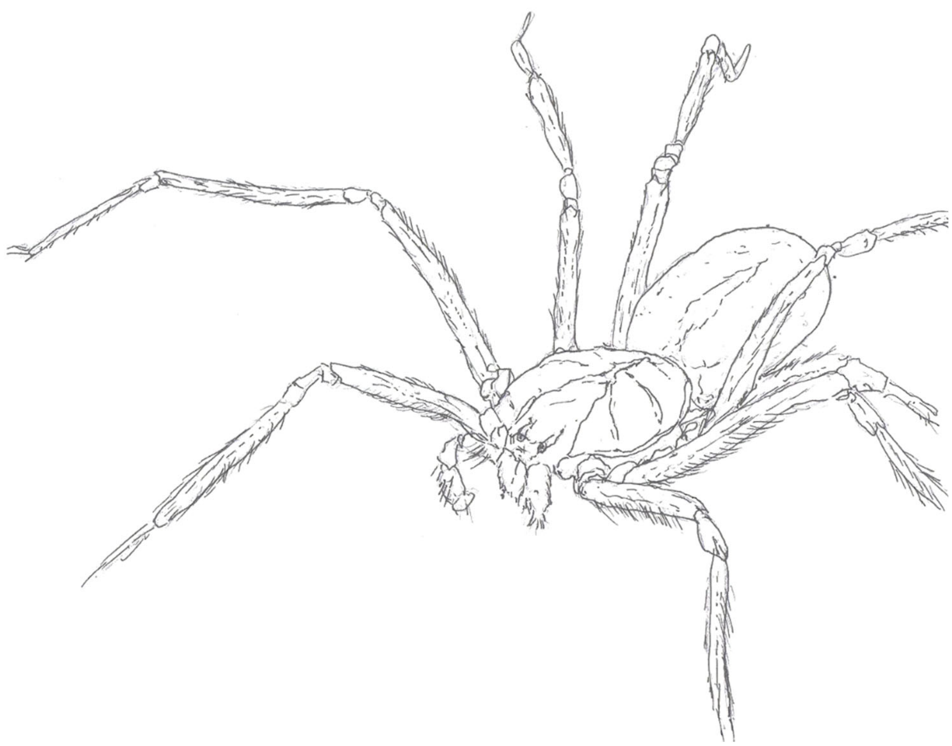
The brown recluse spider is nocturnal and prefers food such as firebrats, crickets, Arachnides, and other soft-bodied creatures. Earning their name well, the brown recluse spider ceases its wanderings at first light.

People are most commonly bitten in bed, while changing clothes, or cleaning storage areas. Not only will this spider hide in cracks and crevices of the home, they will often climb into clothing or shoes that someone has laid out to wear the following day.

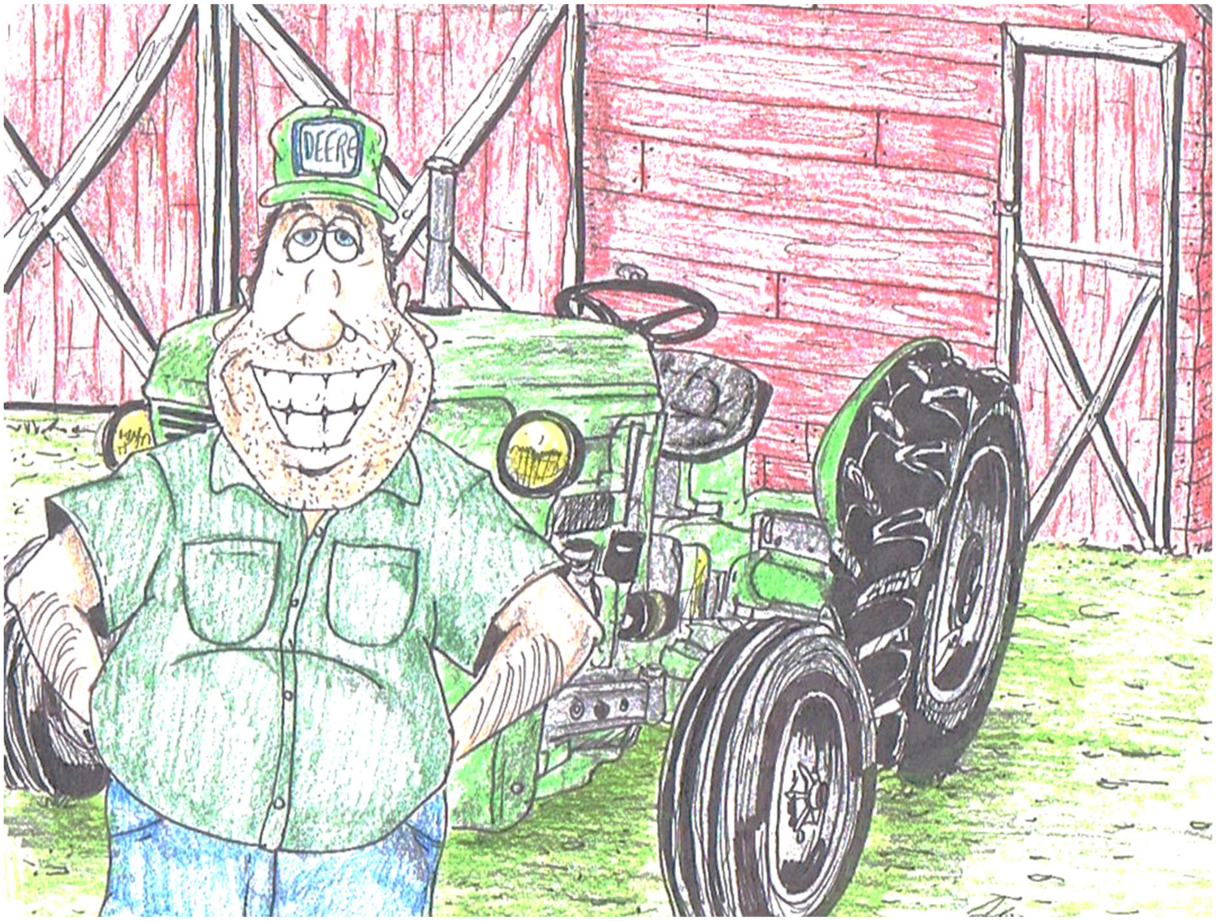
A female deposits eggs in off-white silken cases about 1/3 inch in diameter in sheltered, dark areas. Spiderlings emerge in 24-36 days and abandon the egg case. Development is slow, influenced by weather conditions and food availability. They reach maturity in 10 to 12 months and can survive long periods of time without food or water. Immature spiderlings resemble adult brown recluse spiders but have lighter coloration. Adult males and females will vary from light tan to dark brown.

Most spiders found in the United States are harmless, with the exception of the black widow and the brown recluse spider. The brown recluse spider — a tiny oval brown spider with a small shape like a violin on its back — is found mostly in midwestern and southern parts of the United States. The bites usually don't hurt at first, and a child might not even be aware of the bite, but in some cases they cause swelling and changes in skin color and a blister.

The black widow spider, which is found all over North America, has a shiny black body and an orange hourglass shape on its underbelly. The venom (poison) in a black widow bite can cause painful cramps that show up within a few hours of the bite. The cramps can start in the muscles around the bite and then spread. The bite may also lead to nausea, vomiting, chills, fever, and muscle aches. If your child has any of these symptoms — or you know that he or she has been bitten — go to the emergency room right away.



VIOLIN SPIDER
(OFTEN CONFUSED WITH BROWN RECLUSE)



There are two types of spiders found around the home:

Ground dwellers and web makers. Spiders which thrive on the ground are usually much stronger than their web building cousins.

These brutes are aggressive, usually nocturnal, great hunters and rely on their strong grip and bite. They stalk food at night and will feed on just about anything which moves. Some species may have toxins to assist in their hunting. When prey is identified, they will usually stalk within pouncing distance, crouch, leap, rip, shred, bite, grab and kill – all within a few moments.

Web builders are spiders which are not built to be on the ground. They are usually fragile, weak, slow, lacking grip and not able to defend themselves when out of their webs. What they lack in physical body they more than make up for with bite. In most cases, they are equipped with toxins that can kill insects quickly and in some cases these toxins are so strong they can be fatal to humans!

Seek medical attention if you think you have a spider bite. If possible, collect up the spider or what remains of it and take with you to your doctor or emergency clinic.

Jumping Spider Sub-Section

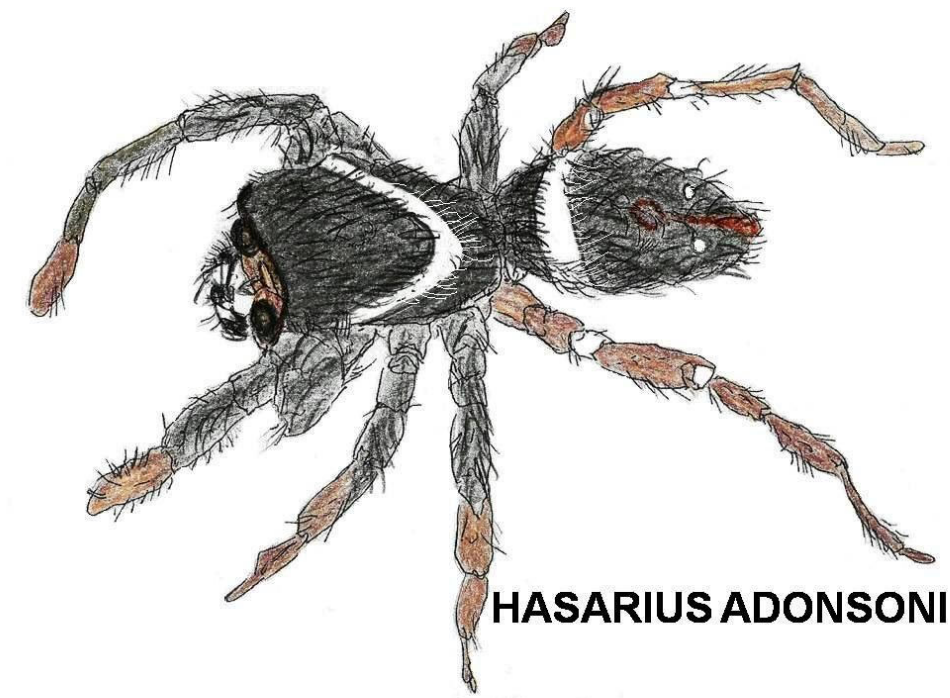
PHISIPPUS CLARUS

The jumping spiders are active hunters. Depending on the species, they can leap up to 25 times their body length when stalking prey. They belong to the family Salticidae, the largest spider family, with more than 4,000 species, in the suborder Araneomorphae. Jumping spiders are found mostly in tropical regions throughout the world, although some species live in high elevation regions in the Himalayas.

Jumping spiders are small spiders, seldom growing larger than 2 cm (0.8 in) in length. Most jumping spiders have somber brown or gray coloration, but a few male species are quite colorful, with iridescent scales and spines and tufts of bright hair. The most striking feature of jumping spiders is their eyes. They have two primary eyes on the front of their cephalothorax that provide exceptionally acute vision. For example, at 20 cm (8 in), they not only see sharp images, but also recognize members of their own species. Their six secondary eyes detect motion. Their excellent eyesight makes these spiders reliant on visual cues for courtship and hunting, and as a result, they are active mostly during the day. At night they hide in crevices or under bark, often in small silken cells that they weave for themselves.

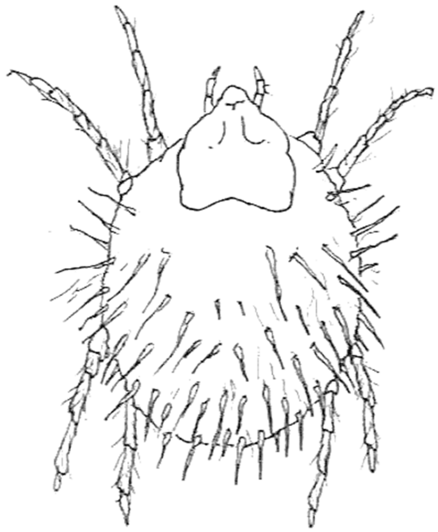
During courtship, the male jumping spider identifies himself by dancing in front of a female waving his legs in a pattern specific to that species. Hunting is also guided by visual cues. The spider’s secondary eyes are able to detect a moving insect, which prompts the spider to turn toward the insect and scrutinize it with its primary eyes.

This overlapping visual field produced by the primary and secondary eyes enables the spider to accurately calculate the distance to the prey. Jumping spiders approach their prey the way a cat stalks a mouse. When the spider comes within a few centimeters of its prey, it suddenly leaps by pushing off the ground with its hind legs and then grabs the prey with its front legs. Muscle power and the hydraulic action of body fluids fuel the explosive force of the jumping spider's legs.



Top jumping spider, below tangle web spider.

Arachnid Classification Orders



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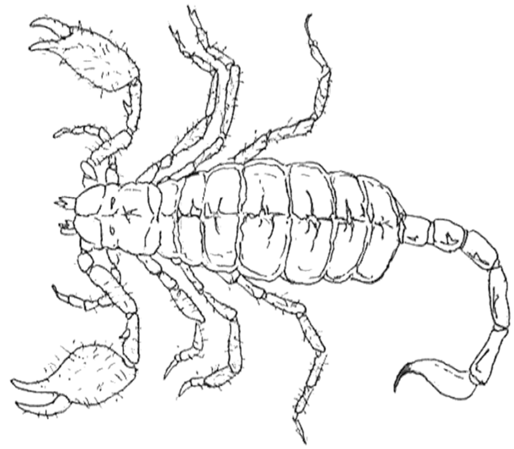

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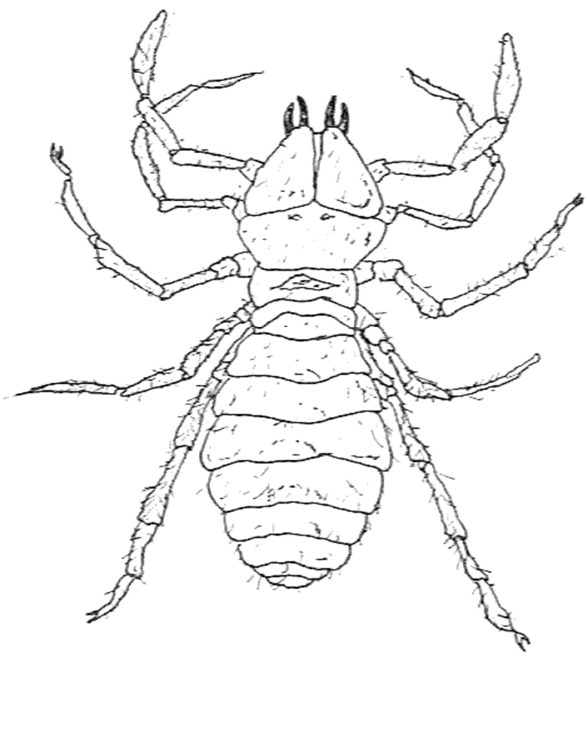

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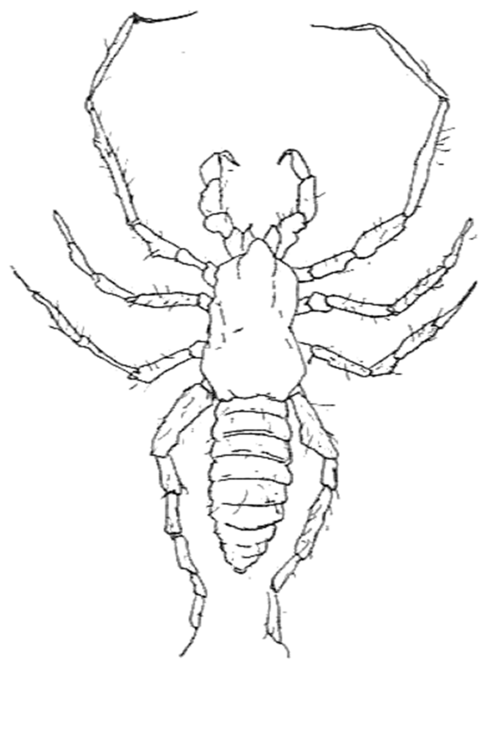

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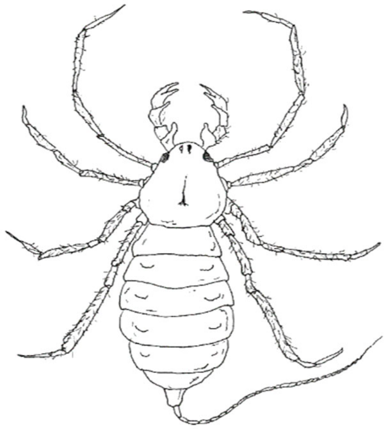

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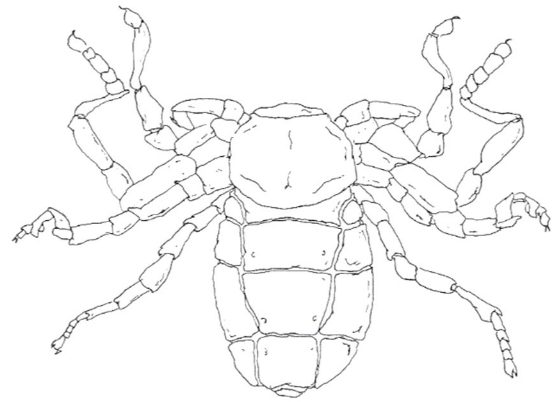

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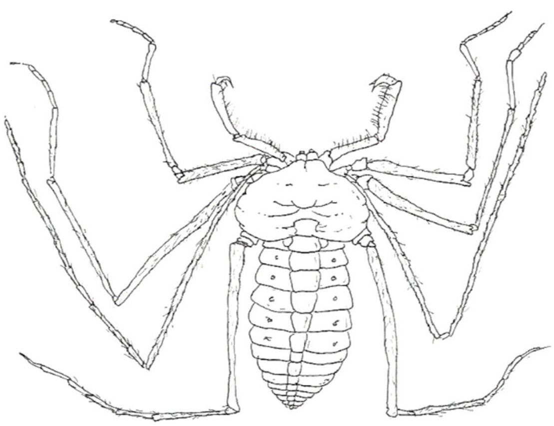
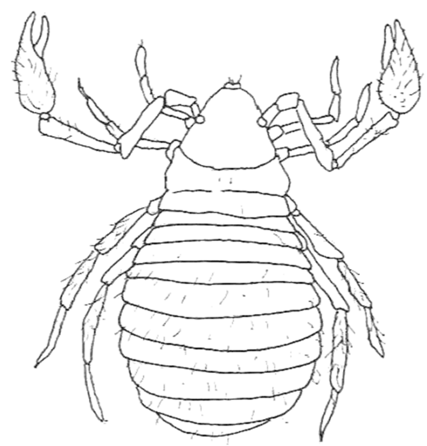


AMBLYPYGI



PSEUDOSCORPION

Common Spider Classifications, Families and Sub-Species Alphabetical Order

Amblypygi
Amblypygi is an order of invertebrate animals belonging to the class Arachnida, in the subphylum Chelicerata of the phylum Arthropoda. They form a separate order of arachnids alongside the spiders, scorpions and others. Amblypygids are also known as whip spiders and tailless whip scorpions (not to be confused with whip scorpions that belong to the Arachnid order Thelyphonida). The name "amblypygid" means "blunt rump", a reference to a lack of the telson ("tail") carried by related species. Despite an off-putting appearance, they are totally harmless to humans. By 2003, 5 families, 17 genera and around 155 species had been discovered. They are found in tropical and subtropical regions worldwide. Some species are subterranean; many are nocturnal. During the day, they may hide under logs, bark, stones, or leaves. They prefer a humid environment.

Amblypygids may range from 4 to 45 millimeters (0.16 to 1.8 in). Their bodies are broad and highly flattened, with a solid carapace and a segmented abdomen. They have a pair of median eyes at the front of the carapace, and three smaller eyes placed further back on each side. The pedipalps are large and somewhat pincer-like, being adapted for grabbing prey. As in some other arachnid orders, the first pair of legs are modified to act as sensory organs, while the animal uses the other six legs for walking. The sensory legs are very thin, have numerous sensory receptors, and can extend several times the length of body. Typically, the animal holds one of these legs out in front of it as it moves, and uses the other to probe the terrain to the side. Amblypygids have no silk glands or venomous fangs.

Amblypygids often move about sideways on their six walking legs, with one "whip" pointed in the direction of travel while the other probes on either side of them. Prey are located with these "whips", captured with pedipalps, then masticated with chelicerae. Courting rituals involve the male depositing stalked spermatophores which have one or more sperm masses at the tip on the ground and guiding the female with his pedipalps over them. She gathers the sperm and lays fertilized eggs into a sac carried under the abdomen. When the young hatch, they climb up onto the mother's back; any of which falling off before their first molt will be eaten by the mother. Amblypygids, particularly the species Phrynus marginemaculatus and Damon diadema, are thought to be one of the few species of arachnids that show signs of social behavior. Research conducted at Cornell University by entomologists suggests that mother amblypygids communicate with their young by caressing the offspring with her anteniform front legs. Further, in an experiment where two or more siblings were placed in an unfamiliar environment, such as a cage, they would seek each other out and gather back in a group.

Anelosimus Spiders
Anelosimus is a genus of tangle web spider (Theridiidae) described by Eugène Simon, in 1891, from Venezuela. It includes the South American social spider Anelosimus eximius and related species. A colony of A. eximius social spiders in the Amazon forest is a wonder of nature and a show-stopper for the naturalist or eco-tourist. The capture strands of the colony's web can reach 8 m into the canopy, and the basket-like retreat at 30 to 150 cm above the ground can be up to 3 m in diameter. A colony may house more than 1000 spiders.

Atrax

These spiders are medium-to-large in size, with body lengths ranging from 1 cm to 5 cm (0.4" to 2"). They are darkly colored, ranging from black to blue-black to plum to brown, with a glossy, hairless carapace covering the front part of the body. Like the related diplurid spiders, some hexathelids have relatively long spinnerets; this is especially true of A. robustus. Like other Mygalomorphae (also incorrectly called Orthognatha) —an infraorder of spiders that includes the tropical tarantulas —these spiders have fangs which point straight down the body and do not point towards each other (cf Araneomorphae).

They have ample venom glands that lie entirely within their chelicerae. Their fangs are large and powerful, capable of penetrating fingernails and soft shoes.

Funnel-webs make their burrows in moist, cool, sheltered habitats—under rocks, in and under rotting logs, some in rough-barked trees (occasionally meters above ground). They are commonly found in suburban rockeries and shrubberies, rarely in lawns or other open terrain. A funnel-web's burrow characteristically has irregular silk trip-lines radiating from the entrance. Unlike some related trapdoor spiders, funnel-webs do not build lids to their burrows.

Araneida

A large class of arthropods including spiders and ticks and scorpions and daddy longlegs; have four pairs of walking legs and no wings.

Araneomorphae

The Araneomorphae (also called the Labidognatha) are a suborder of spiders. They are distinguished by having fangs that oppose each other and cross in a pinching action, in contrast to the Mygalomorphae (tarantulas and their close kin), which have fangs that are nearly parallel in alignment. Almost all of the familiar spiders are included in this group. The major exception is the Tarantulas, which have become as common as pets that many people have seen them. There are a few other members of Mygalomorphae that one might see around homes or gardens, but they typically are relatively small and not easily noticed. For instance, the females of one such species lives and hunts from within a long silken tube, so unless one opens the tube or chances upon a male looking for a mate, one will never see them. The Araneomorphae, to the contrary, include the weavers of spiral webs, the cobweb spiders that live in the corners of our rooms and between windows and screens, the crab spiders that lurk on the surfaces of the flowers in our gardens, the jumping spiders that look back at us curiously from walls and tree trunks, the wolf spiders that sometimes carpet good hunting sites in a sunny spot in the lawn, the large Huntsman spiders that sometimes frighten people by getting into their cars or taking up residence behind wall clocks.

Cellar Spider or Daddy Longlegs

The cellar spider or daddy longlegs (Pholcus phalangioides), also known as the skull spider due to its cephalothorax looking like a human skull, is a spider of the family Pholcidae. Females have a body length of about 9 mm; males are slightly smaller. Its legs are about 5 or 6 times the length of its body (reaching up to 7 cm of leg span in females). Its habit of living on the ceilings of rooms, caves, garages or cellars gives rise to one of its common names. In Australian homes, they are considered beneficial because it is sometimes believed they will kill and eat the venomous Redback spider. This is the only spider species described by the Swiss entomologist Johann Kaspar Füssli who first recorded it for science in 1775.

Confusion often arises over its common name, because "daddy longlegs" is also applied to two other unrelated arthropods: the harvestman and the crane fly. Pholcus phalangioides has the habit of shaking its web violently when disturbed as a defense mechanism against predators. They can easily catch and eat other spiders (even those much larger than itself, such as Tegenaria duellica), mosquitoes and other insects, and woodlice.

When food is scarce, they will prey on their own kind. Because they originally came from the tropics, these spiders do not appear to be influenced by seasonal changes and breed at any time of the year. The female holds the 20 to 30 eggs in her pedipalps. Spiderlings are transparent with short legs and change their skin about 5 or 6 times as they mature.

Chelicerata

The subphylum (or phylum Chelicerata constitutes one of the major subdivisions of the phylum (or superphylum) Arthropoda, and includes horseshoe crabs, scorpions, spiders and mites. They originated as marine animals, possibly in the Cambrian period, but the first confirmed chelicerate fossils, eurypterids, date from the Late Ordovician period. The surviving marine species include the four species of Xiphosurans (horseshoe crabs), and possibly the 1,300 species of Pycnogonida (sea spiders), if the latter are chelicerates. On the other hand, there are over 77,000 well-identified species of air-breathing chelicerates, and there may be about 500,000 unidentified species.

Chelicerata
Segmented Bodies with Jointed Limbs

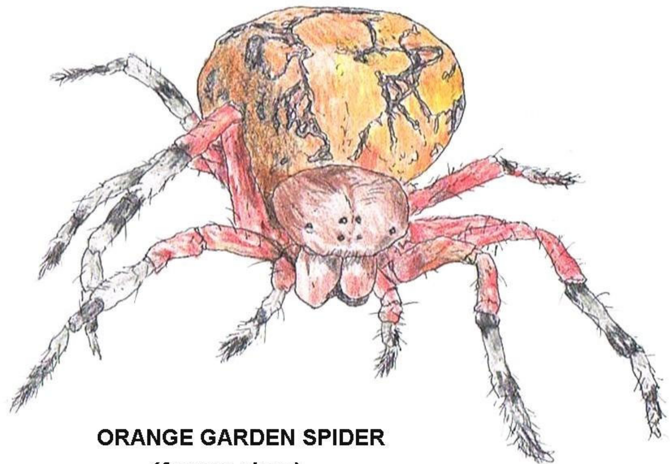
Like all arthropods, chelicerates have segmented bodies with jointed limbs, all covered in a cuticle made of chitin and proteins. The chelicerate bauplan consists of two tagmata, the cephalothorax and the abdomen, except that mites have lost a visible division between these sections. The chelicerae, which give the group its name, are the only appendages that appear before the mouth. In most sub-groups they are modest pincers used in feeding.

However, spiders' chelicerae form fangs which in most species are used to inject venom into their prey. The group has the open circulatory system typical of the arthropods, in which a tube-like heart pumps blood through the hemocoel, which is the major body cavity.

Marine chelicerates have gills, while the air-breathing forms generally have both book lungs and tracheae. In general, the ganglia of living chelicerates' central nervous systems fuse into large masses in the cephalothorax, but there are wide variations and this fusion is very limited in the Mesothelae, which are regarded as the oldest and most primitive group of spiders. Most chelicerates rely on modified bristles for touch and for information about vibrations, air currents, and chemical changes in their environment. The most active hunting spiders also have very acute eyesight.

Chelicerates were originally predators, but the group has diversified to use all the major feeding strategies: predation, parasitism, herbivory, scavenging and eating decaying organic matter. Although harvestmen can digest solid food, the guts of most modern chelicerates are too narrow for this, and they generally liquidize their food by grinding it with their chelicerae and pedipalps and flooding it with digestive enzymes.

To conserve water, air-breathing chelicerates excrete waste as solids that are removed from their blood by Malpighian tubules, structures which also evolved independently in insects. While the marine horseshoe crabs rely on external fertilization, air-breathing chelicerates use internal but usually indirect fertilization. Predatory species generally use elaborate courtship rituals to prevent males from being eaten before they can mate. Most lay eggs that hatch as what look like miniature adults, but all scorpions and a few species of mites keep the eggs inside their bodies until the young emerge. In most chelicerate species the young have to fend for themselves, but in scorpions and some species of spider the females protect and feed their young.



ORANGE GARDEN SPIDER
(Aranea gigas)

Although the venom of a few spider and scorpion species can be very dangerous to humans, medical researchers are investigating the use of these venoms for the treatment of disorders ranging from cancer to erectile dysfunction. The medical industry also uses the blood of horseshoe crabs as a test for the presence of contaminant bacteria. Genetic engineers have experimented with modifying goats' milk and plants' leaves to produce spider silk. Mites can cause allergies in humans, transmit several diseases to humans and their livestock, and are serious agricultural pests.

Cheiracanthium
Cheiracanthium is a genus of spiders in the Miturgidae family. Certain species are commonly known as the "yellow sac spider. Cheiracanthium are usually pale in color, and have an abdomen that can range from yellow to beige. Both sexes range in size from 5 to 10 mm. Some yellow sac spiders are attracted to the smell of hydrogen oxide in gasoline. An unusual double pipe configuration in the Mazda 6 led to a recall of around 65,000 Mazda 6 vehicles in the US, Canada, Mexico and Puerto Rico from the 2009-10 model years after it was found that yellow sac spiders were building nests in the fuel line of the vehicles.

Cybaeidae (Water Spiders)
Small web-building spiders that typically live on the ground in forests (no common name). This family includes the highly unusual European spider Argyroneta aquatica that lives entirely underwater. While the water spider is the only representative of the family in northern Europe, three more species in the Cybaeus genus are found in central and southern Europe.

The only species in this genus, Argyroneta aquatica, is also known as the water spider. It is a special spider because it lives in water. The scientific name of the spider, Argyroneta, means 'with a silvery net'. The silvery net is the air bubble that surrounds the spider, which it needs to breathe. Special hairs on the skin of the spider give it the ability to keep the air attached to its body. The spider has to go to the surface regularly to refresh the air.

Argyroneta aquatica
Argyroneta aquatica constructs a web under water and fills it with air. She catches air from the surface and releases the air bubble from her body with her legs. This is repeated until there is enough air in her 'diving bell'. Diffusion and oxygen bubbles released by the water plants also add air in the bubble. Prey is caught under water, killed by a poisonous bite and consumed in the air bubble in her web. The spider is a good hunter under water and swims quickly between the water plants. Change of skin is done outside the water or in a separate diving bell.

There is hardly any foreplay before mating and male and female stay together for some time. The eggs with the spiderlings are packed in a white sac in a separate air bubble in late spring or early summer. Late in autumn her nest is sealed and the spider stays there during wintertime. The male is 9-12 mm large and the female 8 -15 mm and both are light to dark yellow-brown. The spider can be found in vegetated, fresh, not running water. The bite of the spider is very annoying to humans and should be avoided.

Cyphophthalmi
The Cyphophthalmi are a suborder of harvestmen, with about 36 genera, and more than hundred described species. The six families are currently grouped into two infraorders, the Tropicophthalmi and the Temperophthalmi; however, these are not supported by modern phylogenetic analysis. They are smaller than the more familiar "daddy long-legs" harvestmen, with adults ranging from 1 to 6mm, including legs. Moreover, their legs are comparatively short compared to their body length, typically shorter than the body. Some superficially resemble mites. Their coloration is almost always some shade of brown, with a heavily sclerotized body, and they are quite inconspicuous, residing in leaf litter or in caves. Many cyphophthalmids are eyeless, and presumably rely on olfactory cues to find food and mates. Their scent glands are located on special elevated cones called ozophores. They have low dispersal rates and consequently high endemism.

Dyspnoi
The Dyspnoi are a suborder of harvestmen, with about 32 genera, and about 320 described species. Several fossil species are known, including two extinct families. The superfamilies Ischyropsalidoidea and Troguloidea are monophyletic. However, the families Sabaconidae and Ceratolasmatidae are not; amongst other inconsistencies, Taracus (Sabaconidae) is a sister group to Hesperonemastoma (Ceratolasmatidae). The Dyspnoi are one of the most conserved biogeographically conserved higher groups of harvestmen.

None occur in the Southern Hemisphere, and most families are restricted along temperate regions. The only exceptions are some Ortholasmatinae (Nemastomatidae) inhabiting the tropics on high mountains in Mexico (Ortholasma bolivari) and northern Thailand (Dendrolasma angka). Some Troguloidea were also found in tropical regions during the Cretaceous.

Eupnoi
The Eupnoi are a suborder of harvestmen, with more than 200 genera, and about 1,700 described species. They consist of two superfamilies, the Phalangioidea with many long-legged species common to northern temperate regions, and the small group Caddoidea, which have prominent eyes and spiny pedipalps. Examples of this suborder include Hadrobunus grandis (Sclerosomatidae), Phalangium opilio and Dicranopalpus ramosus (Phalangiidae).

Gerridae (Water Striders, not Spiders)
Gerridae is a family of true bugs in the order Hemiptera, commonly known as water striders, water bugs, magic bugs, pond skaters, skaters, skimmers, water scooters, water skaters, water skeeters, water skimmers, water skippers, water spiders, or Jesus bugs. One main characteristic that sets gerrids and other true bugs apart from other insects is that the front wing is only half functional. Rather than using it for flight, it acts as a membranous covering and the thickened part is by where claws develop. Consistent with the classification of Gerridae as true bugs, gerrids have a mouthpart evolved for piercing and sucking, Gerrids distinguish themselves by having the unique ability to walk on water. Gerridae, or water striders, are anatomically built to transfer their weight to be able to run on top of the water's surface. As a result, one could likely find water striders present in any pond, river, or lake. Scientists have identified over 1,700 species of Gerrids, 10% of them being marine.

Freshwater Bugs
While 90% of Gerridae are freshwater bugs, it is the oceanic Halobates that helped the entire Gerridae family to gain attention. The genus Halobates was first heavily studied between 1822 and 1883 when Buchanan-White collected several different species during the Challenger Expedition. Around this time, Eschscholtz discovered three species of Family Gerridae, Order Hemiptera, raising attention to the species even though little of their biology was known. Since then, the Gerridae have been continuously studied due to their ability to walk on water and unique social characteristics. Small gerrids have frequently been confused with the other semiaquatic bugs, Veliidae.

The most consistent characteristic used to separate these two families are internal genitalia differences. Since internal genitalia require specific training and tools to identify, it is almost impossible to tell a member of the Gerridae apart from a member of the Veliidae by external visual cues. One must study their habitat and behaviors to properly differentiate the two without looking at their specific anatomy.

Gnaphosidae (Ground Spiders)
Ground spiders (family Gnaphosidae) include nearly 2,000 described species in over 100 genera, distributed worldwide. This makes the family the seventh largest known. New species are still being discovered. They are closely related to Clubionidae. Generally, ground spiders are characterized by having barrel-shaped anterior spinnerets that are one spinneret diameter apart. The main exception to this rule is found in the ant-mimicking genus Micaria.

Another characteristic is an indentation in the endites (paired mouthparts anterior and lateral to the labium, or lip). All ground spiders lack a prey-capture web and generally run prey down on the surface. They hunt at night and spend the day in a silken retreat. The thick-walled egg sacs are guarded by the mother until the spiderlings hatch. At present, no ground spiders are known to be seriously venomous to humans. Very few people even notice them. Common genera include Gnaphosa, Drassodes, Micaria, Cesonia, Zelotes and many others.

Habronattus
Habronattus includes approximately 100 species of jumping spiders, most from North America, the remainder in the neotropics. Most are ground-dwelling on open ground with sparse vegetation, especially on rocks, dry leaf litter and sand. The arid southwest has many species, but Florida also has many species, and others are known above the Arctic Circle and east to maritime Canada. The genus was recently revised by Griswold (1987), and its phylogeny studied by Maddison and Hedin (2003). The genus is notable for the remarkable forms and colors of the courtship ornaments of males, which are used in complex courtship behaviors.

Harvestmen (Daddy Long Legs)
Opiliones (formerly Phalangida) are an order of arachnids commonly known as harvestmen. Over 6,400 species of harvestmen have been discovered worldwide, although the real number of extant species may exceed 10,000.

The order Opiliones can be divided into four suborders: Cyphophthalmi, Eupnoi, Dyspnoi and Laniatores. Well-preserved fossils have been found in the Rhynie cherts of Scotland, which look surprisingly modern, indicating that the basic structure of the harvestmen has not changed much since then. Phylogenetic position is disputed: their closest relatives may be the mites (Acari) or the Novogenuata (the Scorpiones, Pseudoscorpiones and Solifugae).

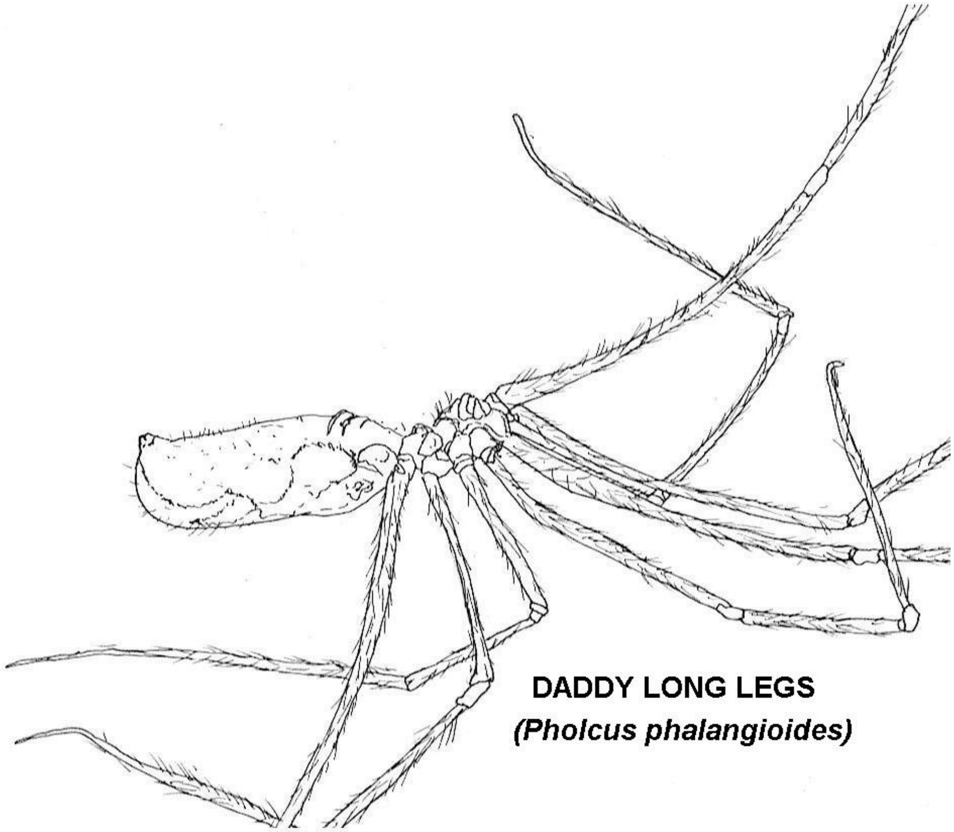
Not Spiders
Although they belong to the class of arachnids, harvestmen are not spiders, which are of the order Araneae rather than the order Opiliones. In some places, harvestmen are known by the name "daddy longlegs" or "granddaddy longlegs", but this name is also used for two other unrelated arthropods: the crane fly (Tipulidae) and the cellar spider (Pholcidae). Opiliones like spiders and scorpions are arachnids, so there are always questions about whether or not they follow spider practices and bite humans.

There is a common myth that Daddy Longlegs are the most venomous of all spiders but have a mouth too small to bite. This is untrue. They are also called harvestmen, and to make matters more confusing, crane flies and cellar spiders also go by the name daddy long legs. Daddy long Legs have eight legs, but only one body part. A close-up picture would also show their two eyes rather than the more common six and eight eyed spiders. They have the nickname harvester because they are omnivores that harvest most insects and plants that cross their path.

Daddy-longlegs do not have fangs or venom for killing prey, and therefore there is no need for humans to be concerned about being bitten by them. It also seems reasonable to assume that since they are omnivorous, eating insects, plants and fruit, they would have to bite or chew the food to eat it. Sometimes the words people choose to explain things are a bit confusing.

Certainly daddy-longlegs eat. Many species are omnivorous, eating primarily small insects and all kinds of plant material and fungi; some are scavengers, feeding upon dead organisms, bird dung and other fecal material. This broad range is quite unusual in arachnids, which are usually pure predators.

Most hunting harvestmen ambush their prey, although active hunting is also found. Because their eyes cannot form images, they use their second pair of legs as antennae to explore their environment. Unlike most other arachnids, harvestmen do not have a sucking stomach or a filtering mechanism. Rather, they ingest small particles of their food, thus making them vulnerable to internal parasites such as gregarines.



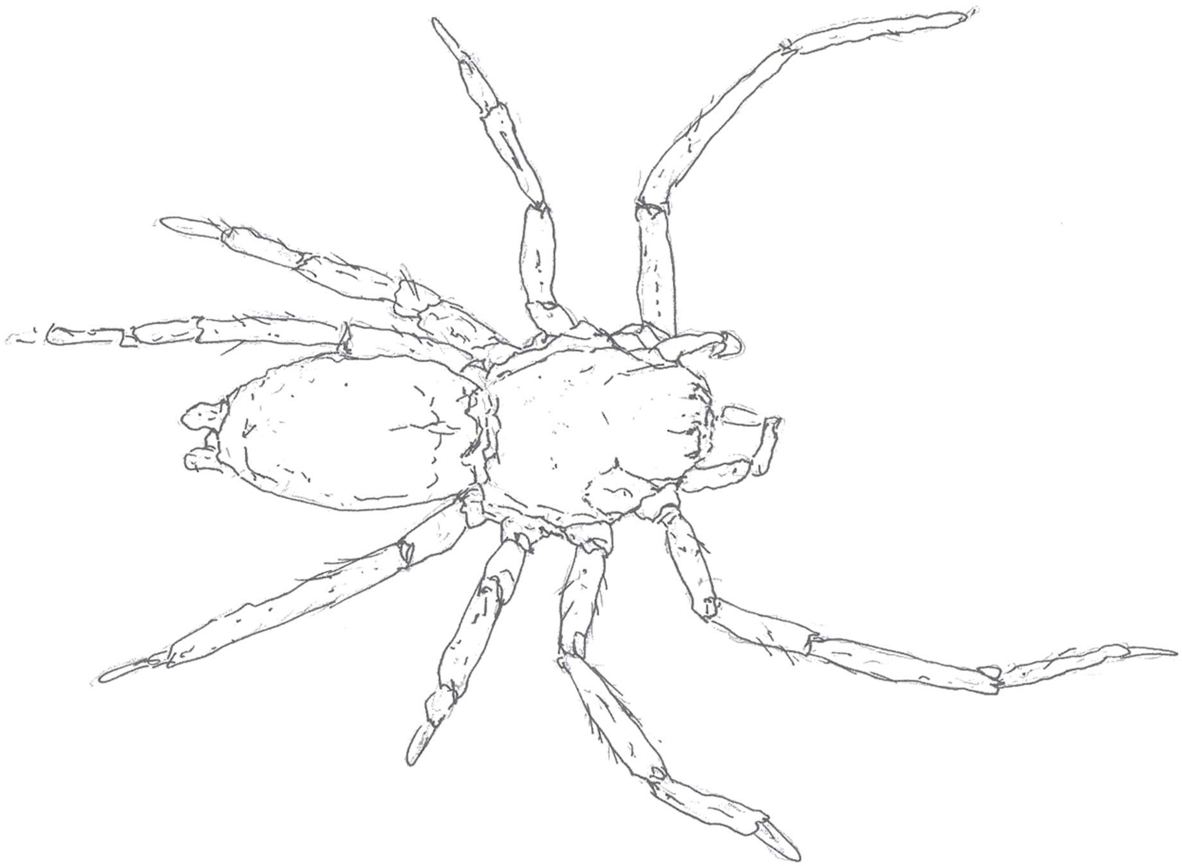
DADDY LONG LEGS
(Pholcus phalangioides)

Hubbardiidae
Hubbardiidae is a family of arachnids, superficially resembling spiders. It is the larger of the two extant families of the order, Schizomida, and is divided into two subfamilies. The family is based on the description published by Orator F. Cook in 1899, and was previously named as Schizomidae.

The American Arachnological Society assigns the common name hubbardiid short tailed whipscorpion to members of this family. The classification of the family includes 28 genera. Seven of these genera are found in Australia, five of them occur nowhere else: Draculoides, Julattenius , Notozomus , Attenuizomus and Brignolizomus. Five genera are found in Mexico, three of which are endemic (Pacal, Mayazomus and Sotanostenochrus).

Laniatore
Laniatores is the largest suborder of the arachnid order Opiliones with over 4,000 described species worldwide. The majority of the species is highly dependent on humid environments and usually correlated with tropical and temperate forest habitats.

Laniatores are typically (relatively) short-legged, hard-plated, spiny Opiliones, common under logs and stones, in leaf litter and in caves. They often have spiny pedipalps and paired or branched claws on the third and fourth pairs of legs. The largest family is Gonyleptidae Sundevall, 1833, endemic of the Neotropics, with over 800 valid species and showing many cases of maternal and paternal care.



SAC SPIDER SPECIES EXAMPLE

Liocranoid (Sac Spiders)
Liocranid sac spiders consist of about 160 species of wandering spiders in 30 or so genera. The best known are those in the Holarctic genus Agroeca. Various genera of rather obscure spiders are included in the family, which still lacks a diagnosis.

Two species in the North American genus Neoanagraphis are found in often hyper-arid conditions in the Mojave, Sonoran and Chihuahuan Deserts. The females apparently live in animal burrows and the males wander and are often caught in pitfall traps.

Loxosceles (Recluse Spiders)
The recluse spiders or brown spiders (genus Loxosceles), also known as fiddle-back, violin spiders or reapers, are a venomous genus of spiders known for their necrotic bite, which sometimes produce a characteristic set of symptoms known as Loxoscelism. Recluse spiders are now identified as members of the family Sicariidae, having formerly been placed in their own family, "Loxoscelidae". Loxosceles is distributed nearly worldwide in warmer areas, and are often known as violin spiders, fiddlebacks or reapers. All have six eyes arranged in three groups of two (dyads) and some are brownish with a darker brown characteristic violin marking on the cephalothorax. However, the "violin marking" cannot be used as a reliable way to identify the spider as literally thousands of species of spider have the same markings.

BROWN RECLUSE

Spiders come with many markings varying greatly within the same species. Most Loxosceles can live for one and a half to two years. Members of both genera can live for very long times without food or water. They are about 7–12 mm long. Because wolf spiders are sometimes seen indoors and because they are usually brown in color, they are often mistaken for brown recluse spiders. If you see a fast-moving, dark-colored spider running on the floor, it is more likely to be a wolf spider than a brown recluse. Brown recluses are very secretive and are almost never seen out in the open. With a little practice, it is easy to tell the difference between wolf spiders and brown recluses.

The recluse spider family includes about 13 species in the United States, the brown recluse spider (Loxosceles reclusa) being the best known of these. It is found in a large area of the Midwest, west to Colorado and the New Mexico state line and east to Northern Georgia. Sporadic records from other locations only represent incidental introductions, not established populations.

Other notable members of this genus include the Chilean recluse (L. laeta) and the Mediterranean recluse (Loxosceles rufescens). Recently, concerns have been raised regarding recluses spreading faster due to warmer air carrying them further as a result of global warming. On the contrary, newly hatched recluses do not travel via ballooning and thus the populations are confined to very tight spaces with dense populations.

Loxosceles spiders, like their cousins in Sicarius, have potent tissue-destroying venoms containing the dermonecrotic agent, sphingomyelinase D, which is otherwise found only in a few pathogenic bacteria. Recent research has indicated the venom is composed largely of sulfated nucleosides, though these compounds are relatively new discoveries, so little is known about them. This venom is highly necrotic in effect, capable of causing lesions (open sores)

as large as a bottle cap. The wounds take a long time to heal and may require skin grafts. If these open wounds become infected there are often serious consequences.
Rarely, the venom is carried by the blood stream to internal organs causing systemic effects. The constituency of recluse venom is identical in both male and female spiders, although females have a particularly potent venom, containing up to twice the concentration of toxins. For unknown reasons, the toxicity of the venom to mammalian species varies—recluse bites will cause necrosis in humans, rabbits, and guinea pigs, but not in mice or rats.

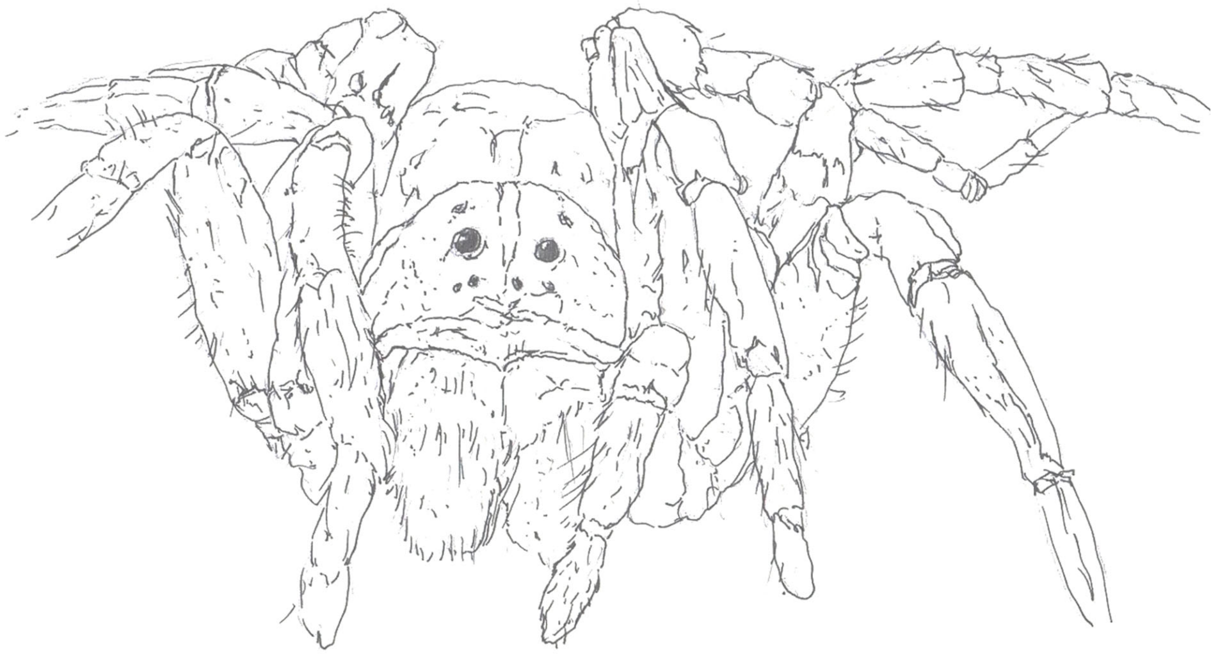
The Chilean recluse (Loxosceles laeta) supposedly has a more potent venom, which results in systemic involvement more often. This spider was accidentally introduced to the Los Angeles area (Alhambra, Sierra Madre, and Monterey Park). This spider, however, seems to be confined to a very limited area, even though it has lived there for over 30 years. Other members of the genus that have been tested have venoms similar to the brown recluse and all members of this genus are best avoided. However, the brown recluse and its relatives are not very aggressive and huge populations have been found in houses where the human inhabitants remained unbitten after years of cohabitation.

A possible problem with diagnosing a recluse spider bite is that the bite of these spiders is probably both underreported in some areas and over reported generally. Unfortunately, several diseases can mimic the lesions of a recluse spider bite, including Lyme disease, various fungal and bacterial infections and the first sore of syphilis. Therefore, it is extremely important to associate the spider directly with the bite, if at all possible, and consider alternative diagnoses if no spider was seen.

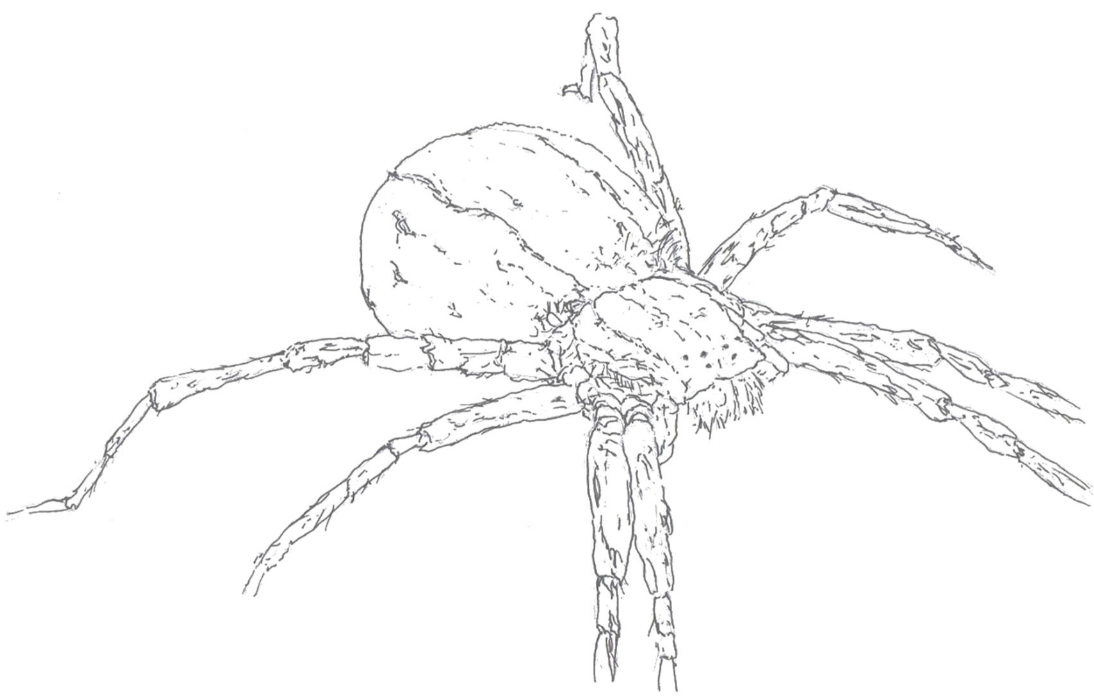
Recluse spiders are usually found in the center of space webs made of fungus-like silk, which often contains the remains of their recent meals. The most abundant food items for the Arizona recluse (Loxosceles arizonica) are night-active ants such as carpenter ants. The brown recluse feeds on whatever small prey is available. This is also true of all sicariids. Loxosceles reclusa have been shown in laboratory experiments to prefer scavenging than actively hunting.

Bites most often occur when the spider is engaging in defense while trapped against the skin, such as when the person is putting on clothes the recluse is inside of, or when the person while sleeping rolls over against the recluse. However, bug spray and other chemicals intended to repel or kill arthropods that do not kill the recluse will cause its nervous system to break down partially, inducing undesirable aggressive behavior.

The bite of a recluse spider can generally be categorized into one of the following groups:
Unremarkable - self-healing minute damage.
Mild reaction - self-healing damage that displays itchiness, redness, and mild lesion. Most bites fall into the unremarkable or mild reaction categories.
Dermonectrotic - (uncommon) necrotic skin lesion (the "classic" recluse bite). Approximately 66% of necrotic lesions caused by this type of bite heal with no complications. In extreme cases, the lesion may expand to as many as 40 cm in width, last for several months, and cause a permanent scar.
Systemic or viscerocutaneous - (extremely rare) a fatal blood system condition. This type of bite is directly related to obesity, and it is life-threatening, particularly to children.



LYCOSA APERSA



NURSERY WEB SPIDER

Lycosidae (Wolf Spiders)

Wolf spiders are members of the family Lycosidae, from an Ancient Greek word “Lycos” meaning "wolf". They are robust and agile hunters with good eyesight. They live mostly solitary lives and hunt alone. Some are opportunistic hunters pouncing upon prey as they find it or even chasing it over short distances. Some will wait for passing prey in or near the mouth of a burrow. Wolf spiders resemble Nursery web spiders (family Pisauridae), but they carry their egg sacs by attaching them to their spinnerets (Pisauridae carry their egg sacs with their chelicerae and pedipalps).

WOLF SPIDER

Two of the Wolf spider's eight eyes are large and prominent, which distinguishes them from the Nursery web spiders whose eyes are all of approximately equal size. There are many genera of wolf spider, ranging in body size from less than 1 to 30 millimeters (0.04 to 1.18 in). They have eight eyes arranged in three rows.

The bottom row consists of four small eyes, the middle row has two very large eyes (which distinguishes them from the Pisauridae), and the top row has two medium-sized eyes. They depend on their excellent eyesight to hunt. They also possess an acute sense of touch. Their eyes reflect light well, allowing someone with a flashlight to easily hunt for them at night. Flashing a beam of light over the spider will produce eyeshine. The light from the flashlight has been reflected from the spider's eyes directly back toward its source, producing a "glow" that is easily noticed. This is also especially helpful because the wolf spiders are nocturnal and will be out hunting for food, making it easier to find them.

Wolf spiders are unique in the way that they carry their eggs. The egg sac, a round silken globe, is attached to the spinnerets at the end of the abdomen, allowing the spider to carry her unborn young with her. The abdomen must be held in a raised position to keep the egg case from dragging on the ground, however despite this handicap they are still capable of hunting.

WOLF SPIDER WITH YOUNG ON HER BACK

Another aspect unique to wolf spiders is their method of infant care. Immediately after the spiderlings emerge from their protective silken case, they clamber up their mother's legs and crowd onto her abdomen. Because they depend on camouflage for protection, they do not have the flashy appearance of some other kinds of spiders. In general, their coloration is appropriate to their favorite habitat.

Hogna is the genus with the largest of the wolf spiders. Among the Hogna species in the U.S., the nearly solid dark brown H. carolinensis (Carolina wolf spider) is the largest, with a body that can be more than one-inch long. It is sometimes confused with H. helluo, which is somewhat smaller and entirely different in coloration. Some members of the Lycosidae, such as H. carolinensis, make deep tubular burrows in which they lurk much of the time. Others, such as H. helluo, seek shelter under rocks and other shelters as nature may provide. They may wander from place to place, and are therefore more likely to be the ones attracted into human habitation when the weather starts to turn colder in autumn.

There are many smaller wolf spiders. They live on pastures and fields and are an important natural control on harmful insects. In most cases, wolf spiders benefit humans by feeding on all sorts of insects, including crop pests. Wolf spiders are rarely pests, but they sometimes wander into houses, where their large size often frightens homeowners. Wolf spiders can bite, but their bites are extremely rare and no more dangerous or painful than bee stings. In fact, bees and wasps are more dangerous than wolf spiders because a wolf spider will never "attack" a person, unlike bees or wasps that will attack to defend a hive. Wolf spiders will only bite if they are handled.

Wolf spiders that are found indoors have wandered in by mistake and should be collected and released outdoors (if you ever need to collect a wolf spider, "herd" the spider into a container with a stick or a pencil).

Because wolf spiders are sometimes seen indoors and because they are usually brown in color, they are often mistaken for brown recluse spiders. If you see a fast-moving, dark-colored spider running on the floor, it is more likely to be a wolf spider than a brown recluse. Brown recluses are very secretive and are almost never seen out in the open. With a little practice, it is easy to tell the difference between wolf spiders and brown recluses

Mimetidae

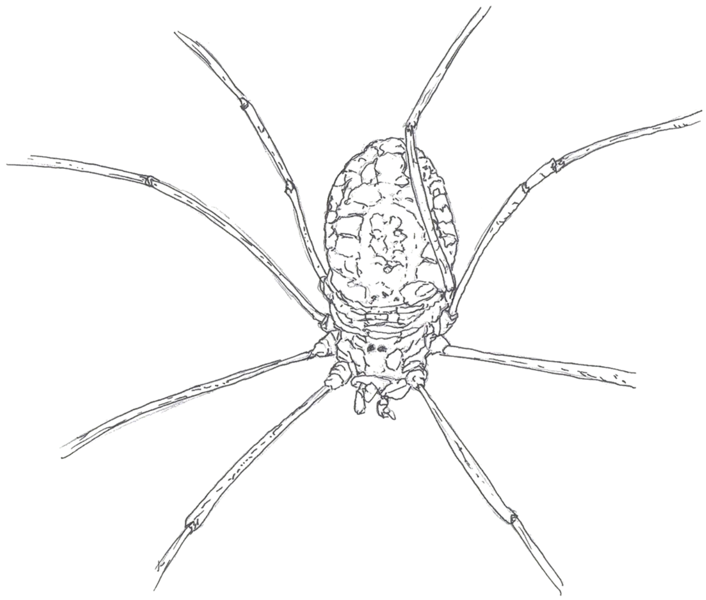
The family Mimetidae, commonly called pirate spiders, are spiders which typically feed on other spiders. The family Mimetidae contains roughly 200 species divided among 12 genera, of which Mimetus and Ero are the most common. Mimetids are usually yellow and brown and are usually 3 to 7 mm long. Mimetids can be recognized by the rows of spine-like hairs on their long front legs; the rows consist of a long spine, followed by a series of progressively shorter ones.

PIRATE SPIDER EXAMPLE

Mimetidae usually hunt by picking at the strands on their prey's web to simulate the movements of either a trapped insect or a potential mate. When their prey comes to investigate, they are instead captured and eaten. Some mimetids have been observed to feed on insects as well.

The spider-feeding habit presents problems in mating, and little is known about how the males court females to avoid being eaten. However, some male mimetids in the genus Gelanor, found in South America, have enormously long appendages which they use to inseminate females. The Mimetidae are sometimes taxonomically grouped in the superfamilies Araneoidea or Palpimanoidea.

Mygalomorphae
The Mygalomorphae, (also called the Orthognatha), are an infraorder of spiders. The latter name comes from the orientation of the fangs which point straight down and do not cross each other (as opposed to araneomorph). This suborder includes the heavy bodied, stout legged spiders popularly known as tarantulas as well as the dangerous Australasian funnel-web spiders. Like the "primitive" Mesothelae, they have two pairs of book lungs, and downward pointing chelicerae. Because of this, the two groups were once believed to be closely related.



DADDY LONG LEGS (HARVESTMAN)

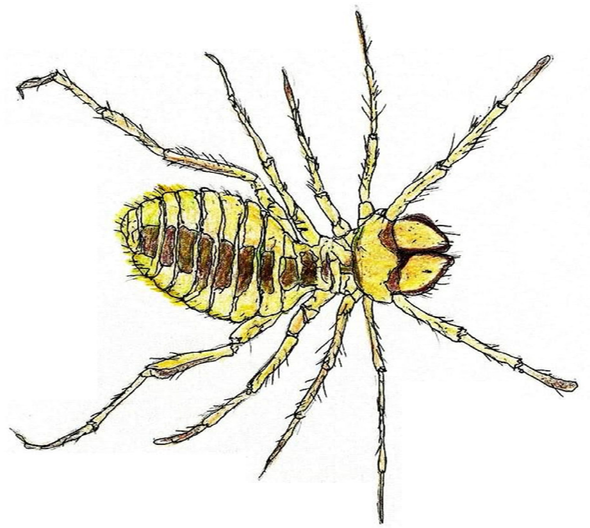
Later it was realized that the common ancestors of all spiders had these features (Symplesiomorphy), and that the mygalomorphs just retained them, while the closely related araneomorphs evolved new features (including a cribellum) (Coddington & Levy, 1991).

Almost all species of Mygalomorphae have eight eyes, however there are some with fewer (Masteria lewisi has only six eyes). They have ample venom glands that lie entirely within their chelicerae, but only spiders of the Australian genus Atrax can be really harmful to humans. Their chelicerae and fangs are large and powerful.

Occasionally members of this suborder will even kill small fish, small mammals, and the like. While the world's biggest spiders are mygalomorphs - Theraphosa blondi (Latreille, 1804) has a body length of 10 cm, and a leg span of 28 cm - some species are less than one millimeter long.

Mygalomorphs are capable of spinning at least slightly adhesive silk, and some build elaborate capture webs that approach a meter in diameter (Coddington & Levy, 1991). Unlike Araneomorphae, which die after about a year, Mygalomorphae can live for up to 25 years, and some don't reach maturity until they are about six years old. Some flies in the family Acroceridae which are endoparasites of mygalomorphs may remain dormant in the book lungs for as long as 20 years before beginning their development and consuming the spider.

Novogenuata
Dromopoda is a subclass of the arachnids, including the Opiliones (harvestmen), Scorpions, Pseudoscorpions and Solifugae ("camel spiders"). The latter three are sometimes grouped as Novogenuata. However, morphological analysis showed the Dromopoda to be monophylic only when fossils were not taken into account.



SUN SPIDER

Oxyopidae (Lynx spiders)
Stalk and capture resting or walking insects. Active hunters with good vision. Most have spiny legs and a brightly colored body that tapers sharply toward the rear. They have four pairs of eyes grouped in a hexagon. About 2 dozen known species in North America.

GREEN LYNX SPIDER

Pantopoda or Pycnogonids (Sea Spiders)
Sea spiders, also called Pantopoda or pycnogonids, are marine arthropods of class Pycnogonida. Sea spiders have long been considered to belong to the Chelicerata, together with horseshoe crabs, true spiders, mites, ticks and scorpions. They are cosmopolitan, found especially in the Mediterranean and Caribbean Seas, as well as the Arctic and Antarctic Oceans. There are over 1300 known species, ranging in size from 1 to 10 millimeters (0.039 to 0.39 in) to over 90 cm (35 in) in some deep water species. Most are toward the smaller end of this range in relatively shallow depths; however, they can grow to be quite large in Antarctic waters.

SEA SPIDER

Although "sea spiders" are not true spiders, or even arachnids, and should not be confused with Water Spiders, their traditional classification as chelicerates would place them closer to true spiders than to other well-known arthropod groups, such as insects or crustaceans. However, this is in dispute, as genetic evidence suggests they may even be an ancient sister group to all other living arthropods. The class Pycnogonida comprises over approximately 1,300 species, which are normally split into eighty-six genera. The correct taxonomy within the group is uncertain, and it appears that no agreed list of orders exists. Accordingly, families are listed in the taxobox, all considered part of the single order Pantopoda.

Another idea is that they belong to their own lineage, distinct from chelicerates, crustaceans, myriapods, or insects. The reason for this is that it seems the appendages called chelifores are unique among extant arthropods, and are not homologous to the chelicerae in real chelicerates as previously supposed. Instead of developing from the deuterocerebrum, they can be traced to the protocerebrum, the anterior part of the arthropod brain and found in the first head segment that in all other arthropods give rise to the eyes only. This is not found anywhere else among arthropods except in some fossil forms like Anomalocaris, indicating that the Pycnogonida may be a sister group to all other living arthropods, the latter having evolved from some ancestor that had lost the protocerebral appendages.

If this is confirmed, it would mean the sea spiders are the last surviving (and highly modified) members of an ancient stem group of arthropods that lived in Cambrian oceans. Recent work places the Pycnogonida outside the Arachnomorpha as basal Euarthropoda, or inside Chelicerata (based on the chelifore-chelicera putative homology).

Phalangiidae

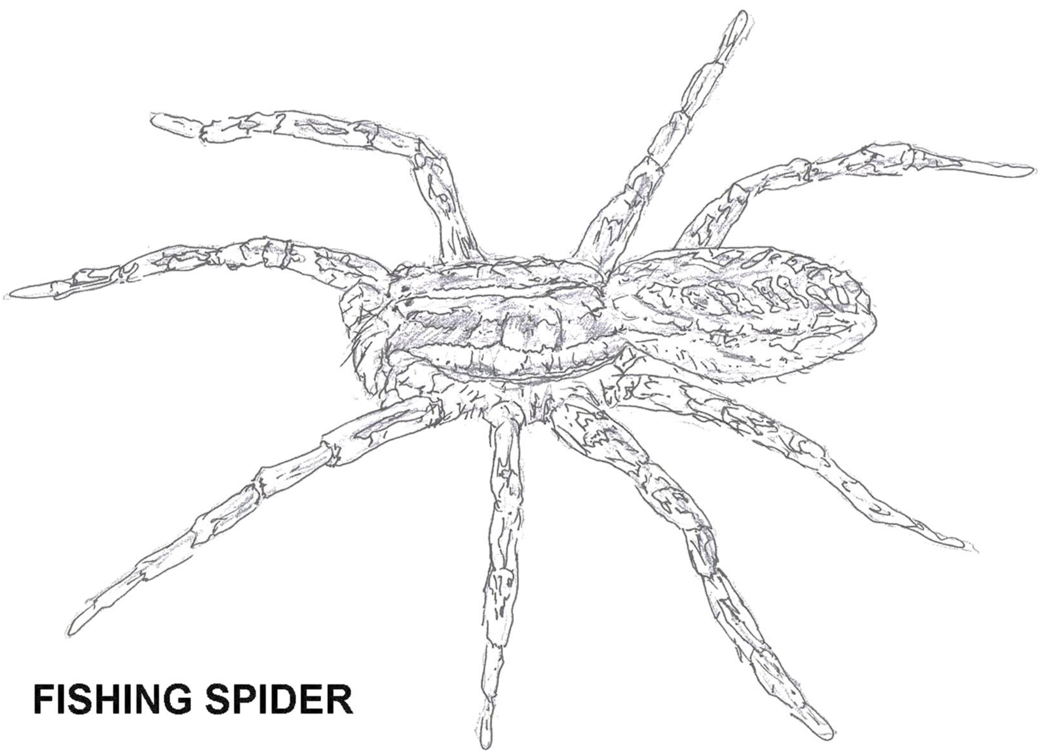
The Phalangiidae are a family of harvestmen with about 380 known species. The best known is Phalangium opilio. Dicranopalpus ramosus is an invasive species in Europe. It is not to be confused with the harvestman family Phalangodidae, which belongs to the suborder Laniatores.

HARVESTMAN

Pisauridae (Nursery-web and fishing spiders) – Human Biters

Nursery-web and fishing spiders are large, hairy spiders in the family Pisauridae. These spiders are typically patterned with black, brown, white, and gray markings. Although difficult to distinguish from wolf spiders, nursery-web and fishing spiders are usually slimmer in build than wolf spiders. Like all spiders, nursery-web and fishing spiders have 8 legs, 2 body parts, and fangs (called "chelicerae"). Nursery-web and fishing spiders have 8 eyes. Simple metamorphosis: like all spiders, young nursery-web and fishing spiders hatch from eggs and look like tiny adults when they are born. They shed their skin as they grow. After laying her eggs, a female nursery-web or fishing spider will wrap them into a silk egg sac. She will then carry the egg sac in her chelicerae until the eggs hatch.

When hatching time arrives, the female will build a "nursery" in which the eggs can hatch. The nursery consists of a few leaves woven together with silk. This forms a protective pocket into which the egg sac is placed. Many spiders in the Pisauridae family are active hunters that search the ground for insects, worms, spiders, and other small creatures.



FISHING SPIDER

Others are ambush predators that wait quietly for prey to come to them. Fishing and nursery-web spiders are common in forests and meadows, especially near streams and creeks, where they patrol rocks and pebbles at the water's edge. Fishing spiders, in particular, are very common around ponds and streams, and will even hunt for prey on the water's surface, usually by holding onto vegetation at the water's edge. Some fishing spiders will partially submerge themselves underwater for brief periods of time to catch aquatic prey.

Although nursery-web and fishing spiders resemble tarantulas, they are not closely related. Nursery-web and fishing spiders are closely related to wolf spiders. Fishing spiders in other parts of the world can grow very large!

Ricinulei

The Order Ricinulei is a group of arachnids known as hooded tickspiders. In older works they are sometimes referred to as Podogona. 60 extant species of ricinuleids have been described worldwide, all in the single family Ricinoididae.

TICKSPIDER

They occur today in west-central Africa (Ricinoides) and the Neotropical region (Cryptocellus and Pseudocellus). In addition to the three living genera, there are two families and four genera containing fossil species. Ricinulei are typically about 5 to 10 millimeters (0.2 to 0.4 in) long. The cuticle (or exoskeleton) of both the legs and body is remarkably thick. Their most notable feature is a "hood" (or cucullus) which can be raised and lowered over the head. When lowered, it covers the mouth and the chelicerae. Living ricinuleids have no eyes, although two pairs of lateral eyes can be seen in fossils and even living species retain light-sensitive areas of cuticle in this position.

The heavy-bodied abdomen (or opisthosoma) exhibits a narrow pedicel, or waist, where it attaches to the prosoma. Curiously, there is a complex coupling mechanism between the prosoma and opisthosoma. The front margin of the opisthosoma tucks into a corresponding fold at the back of the carapace. The advantages of this unusual system are not well understood, and since the genital opening is located on the pedicel (another rather unique feature) the animals have to 'unlock' themselves in order to mate. The abdomen is divided dorsally into a series of large plates or tergites, each of which is subdivided into a median and lateral plate.

Salticidae (Jumping Spiders)
The jumping spider family (Salticidae) contains more than 500 described genera and about 5,000 described species, making it the largest family of spiders with about 13% of all species. Jumping spiders have good vision and use it for hunting and navigating. They are capable of jumping from place to place, secured by a silk tether. Both their book lungs and the tracheal system are well-developed, as they depend on both systems (bimodal breathing). Jumping spiders live in a variety of habitats. Tropical forests harbor the most species, but they are also found in temperate forests, scrub lands, deserts, intertidal zones, and even mountains. Euophrys omnisuperstes is a species reported to have been collected at the highest elevation, on the slopes of Mount Everest. Jumping spiders are generally recognized by their eye pattern. All jumping spiders have four pairs of eyes with very large anterior median eyes.

JUMPING SPIDER

Jumping spiders are generally diurnal, active hunters. Their well-developed internal hydraulic system extends their limbs by altering the pressure of body fluid (hemolymph) within them. This enables the spiders to jump without having large muscular legs like a grasshopper. Most jumping spiders can jump several times the length of their body. When a jumping spider is moving from place to place, and especially just before it jumps, it tethers a filament of silk (or dragline) to whatever it is standing on. Should it fall for one reason or another, it climbs back up the silk tether.

Schizomida

Schizomida (common name short tailed whipscorpion) is an order of arachnids, superficially resembling spiders and generally less than 5 millimeters (0.20 in) in length. The order is not yet widely studied. As of 2005, more than 230 species of schizomids have been described worldwide, most belonging to the Hubbardiidae family.

WHIP SCORPION

Schizomids are relatively small, soft-bodied arachnids, somewhat similar in appearance to whip scorpions. The prosoma (cephalothorax) is divided into three regions, each covered by plates, the large protopeltidium and the smaller, paired, mesopeltidia and metapeltidia. The name means "split or cleaved middle", referring to the way the thorax is divided into two separate plates.

Opisthosoma
The opisthosoma (abdomen) is a smooth oval of 12 recognizable segments. The first is reduced and forms the pedicel, while the last three are constricted, forming the pygidium. The last segment bears a short whip-like tail or flagellum, consisting of no more than four segments. Like the related orders Thelyphonida, Amblypygi, and Solifugae, the schizomids use only six legs for walking, having modified their first two legs to serve as sensory organs. They also have large well-developed pincer-like pedipalps just before the sensory legs.

SCHIZOMID EXAMPLE

Schizomids have no actual eyes, but a few species have vestigial eyespots capable of telling light from dark. Schizomids are generally tropical creatures, although some populations have been found in California and Arizona. They tend to live in the top layer of soil and in the cavities beneath logs and rocks, where they can avoid desiccation. They seek water and avoid light. Some species are cave dwellers, and a few live in or near termite or ant colonies.

Scytodidae – Human Biters
Spitting spiders (family Scytodidae) are spiders of the genus Scytodes and their relatives. There are five known genera and over 150 species of scytodids worldwide. They catch their prey by spitting a fluid that immobilizes it by congealing on contact into a venomous and sticky mass. They can be observed swaying from side to side, in order to cover the prey in a crisscrossed "Z" pattern; each of two pores in the chelicerae emits half of the pattern. The spider usually strikes from a distance of 10-20mm and the whole attack sequence is over in a little under 1/700th of a second.

SPITTING SPIDER – HUMAN BITER

Like the Sicariidae and Diguetidae these spiders are haplogyne (lack hardened female genitalia) and have six eyes, which are arranged as three pairs. They differ from these in having a dome-shaped carapace and in their characteristic flecked pattern of spots. Two scytodes will fight each other, the larger one is strong enough to break free and win.

Spider identification is difficult even for experts. There are about 3,700 species of spiders in North America alone, and there are no doubt many “new” species awaiting descriptions and names from scientists.

Even taking a picture of a spider is no guarantee that one of our experts can tell you what species it is. The characters needed to identify a spider, like the arrangement of its eyes, are often not visible in images. It is helpful, however, to note the kind of web you found the spider in (not all spiders spin webs, though), whether it was outdoors or indoors, and include an accurate assessment of the size of the spider (body length or legspan). Always remember to include a specific geographic location in your post. Lastly, make sure it is actually a spider that you have, and not another arachnid, or even an insect.

Solifugae (Sun Spiders or Wind Scorpions)
Solifugae is an order of Arachnida, known as camel spiders, wind scorpions or sun spiders, comprising more than 1,000 described species in about 153 genera. They may grow to a length of 15 cm (6 in) including legs, and have a body comprising an opisthosoma (abdomen) and a prosoma (head) with conspicuously large chelicerae, which are also used for stridulation. Most species live in deserts and feed opportunistically on ground-dwelling arthropods and other animals. A number of urban legends exaggerate the size and speed of Solifugae, and their potential danger to humans. Solifugids are moderate to large arachnids, with the larger species reaching 15 centimeters (6 in) in length.

SUN SPIDER

The body is divided into a forward part, cephalothorax or prosoma, and a ten-segmented abdomen or opisthosoma. The prosoma comprises the head, mouthparts and somites containing the pedipalps. It is divided into a relatively large anterior carapace, including the animal's eyes, and a smaller posterior section.

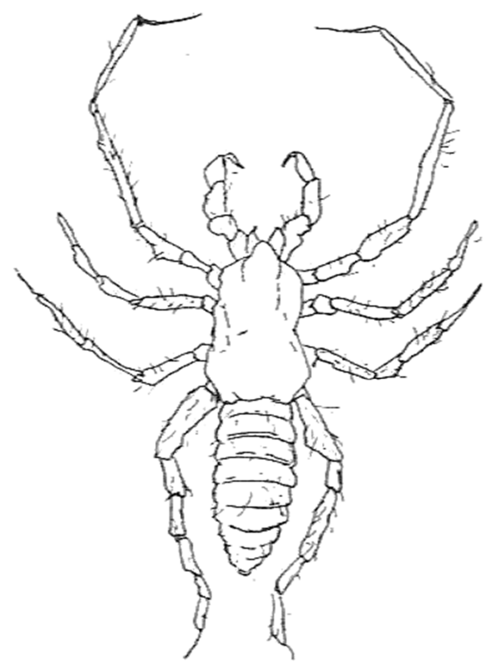
The most distinctive feature of Solifugae is their large chelicerae, which are longer than the prosoma. Each of the two chelicerae are composed of two articles forming a powerful pincer; each article bears a variable number of teeth. While solifuges appear to have ten legs, they have eight legs like other arachnids; the first set of appendages are pedipalps, which function as sense organs similar to insects' antennae and give the appearance of an extra pair of legs.

The pedipalps terminate in eversible adhesive organs, which are used to capture flying prey, and for climbing. They stridulate with their chelicerae, producing a rattling noise. Of the four pairs of legs, the first pair are smaller in size, and act as accessory tactile organs used to feel the animal's surroundings, so that only the other six legs are used for running. On the last pair of legs, Solifugae have fan-shaped sensory organs called racquet organs or malleoli. Like pseudoscorpions and harvestmen, they lack book lungs, having instead a well-developed tracheal system that takes in air through three pairs of slits on the animal's underside. In some species there are very large central eyes that are capable of recognizing forms, and are used for hunting. Lateral eyes are only rudimentary, if present at all. Males are usually smaller than females, with longer legs.

Theridiidae
Theridiidae is a large family of spiders, also known as the tangle-web spiders cobweb spiders and comb-footed spiders. The diverse family describes over 2200 species in over 100 genera) of three-dimensional space-web-builders found throughout the world. Theridiid spiders are entelegyne (have a genital plate in the female) araneomorph ecribellate (use sticky capture silk instead of woolly silk) spiders that often build tangle space webs and have a comb of serrated bristles (setae) on the tarsus of the fourth leg.

The family includes some model organisms for research, for example, the genus Latrodectus, the medically important widow spiders. In addition to studies characterizing their venom and its clinical manifestation, widow spiders are broadly used in research on spider silk, and on sexual biology including sexual cannibalism. Anelosimus spiders are also model organisms, used for the study of sociality, its evolution, and its ecological and evolutionary causes and consequences.

They are particularly important for such studies as the genus contains species varying from solitary to permanently social, and because sociality has evolved frequently within the genus allowing comparative studies across species.
These spiders are also a promising model for the study of inbreeding as their mating system co-varies with sociality, and all permanently social species are highly inbred. One species in Theridion, the Hawaiian T. grallator, is used as a model to understand the selective forces and the genetic basis of color polymorphism within species. Theridion grallator is known as the "happyface" spider, as certain morphs have a pattern uncannily resembling a smiley face or a grinning clown face on their yellow body.



SCHIZOMIDA

The family also contains the well-studied kleptoparasitic species of the subfamily Argyrodinae (including Argyrodes, Faiditus, and Neospintharus) which often have triangular bodies.

These spiders live in the webs of larger spiders and pilfer small prey caught by their host's web, eat prey killed by the host spider, and may consume silk from the host web, as well as attack and eat the host itself. The largest genus with over 600 species currently placed in it is Theridion, but it is not monophyletic. Another large genus is Parasteatoda, previously Achaearanea, which includes the common house spider. Many theridiids trap ants and other ground dwelling insects by means of elastic sticky silk trap lines leading to the soil surface. Despite their name, cobweb or tangle-web spiders have a huge range of web architectures.

Vinegarroons
Vinegarroons range from 25 to 85 mm (0.98 to 3.3 in) in length, with most species not longer than 30 mm (1.2 in); the largest species, of the genus Mastigoproctus, reaching 85 mm (3.3 in). Like the related orders Schizomida, Amblypygi, and Solifugae, the vinegarroons use only six legs for walking, having modified their first two legs to serve as antennae-like sensory organs.

VINEGARRON

Many species also have very large scorpion-like pedipalps (pincers). They have one pair of eyes at the front of the cephalothorax and three on each side of the head, a pattern also found in scorpions. Vinegarroons have no venom glands, but they do have glands near the rear of their abdomen that can spray a combination of acetic acid and octanoic acid when they are bothered. The acetic acid gives this spray a vinegar-like smell, giving rise to the common name vinegarroon.

Carnivorous, Nocturnal hunters
Vinegarroons are carnivorous, nocturnal hunters feeding mostly on insects and millipedes, but sometimes on worms and slugs. Mastigoproctus sometimes preys on small vertebrates. The prey is crushed between special teeth on the inside of the trochanters (the second segment of the leg) of the front legs.

They are valuable in controlling the population of roaches and crickets. Males secrete a sperm sac, which is transferred to the female. Up to 35 eggs are laid in a burrow, within a mucous membrane that preserves moisture. Mothers stay with the eggs and do not eat. The white young that hatch from the eggs climb onto their mother's back and attach themselves there with special suckers.

After the first molt they look like miniature vinegarroons, and leave the burrow; the mother dies soon after. The young grow slowly, going through three molts in about three years before reaching adulthood. They live for up to another four years.

SPIDER CONTROL WITH USE OF SPRAY PESTICIDES

To avoid harm from the pesticide, you should:

• Pour the clothes from their container into the washer without touching them.
• Handle only the inner surfaces, such as the inside of boots, aprons, or coveralls.
• Do not breathe the steam from the washer and dryer.

Always follow the label's instructions no matter the case or what you think might work. Applicators go to jail and are given large fines for not following the label.

You should wear work clothing that protects your body from pesticide residues, such as long-sleeved shirts, long pants, shoes, and socks. If possible, avoid touching the parts of the equipment where the pesticide is most likely to be. Or, if practical for the job that you will be doing, consider wearing rubber or plastic gloves and an apron.

You should not let pesticides stay on your hands:

• Wash your hands as soon as you finish handling the equipment.
• Wash your hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
• Wash or shower with soap and water, shampoo your hair, and put on clean clothes after work.
• Wash work clothes that may have pesticides on them separately from other clothes before wearing them again.

Scorpions – Human Biter/Stinger

Note: The word scorpion is sometimes misspelled as scorpian, and the plural scorpions have sometimes been misspelled as scorpians or scorpiones. The correct spellings are scorpion and scorpions.

Scorpions are arachnids, close relatives of ticks, mites and spiders. There are approximately 1,300 species of scorpions worldwide, characterized by an elongated body and a segmented tail that is tipped with a venomous stinger. Scorpions are very common in the Southern and Southwestern States. Most are not poisonous, except for two species found in the southwestern states like Arizona, California, New Mexico, and Texas.

Scorpions are commonly thought of as desert animals, but in fact, they occur in many other habitats as well, including grasslands and savannahs, deciduous forests, pine forests, rain forest and caves.

Scorpions are opportunistic predators of small arthropods, although the larger kinds have been known to kill small lizards and mice. The large pincers are studded with highly sensitive tactile hairs, and the moment an insect touches these, they use their chelae (pincers) to catch the prey. Depending on the toxicity of their venom and size of their claws, they will then either crush the prey or inject it with neurotoxic venom. This will kill or paralyze the prey so the scorpion can eat it.

Scorpions have a relatively unique style of eating using chelicerae, small claw-like structures that protrude from the mouth that are unique to the Chelicerata among arthropods. The chelicerae, which are very sharp, are used to pull small amounts of food off the prey item for digestion into a pre-oral cavity below the chelicerae and carapace. Scorpions can only ingest food in a liquid form; they have external digestion. The digestive juices from the gut are egested onto the food and the digested food sucked in liquid form. Any solid indigestible matter (fur, exoskeleton, etc.) is trapped by setae in the pre-oral cavity, which is ejected by the scorpion.

Predatory Arthropod
Scorpions are predatory arthropod animals of the order Scorpiones within the class Arachnida. They have eight legs and are easily recognized by the pair of grasping claws and the narrow, segmented tail, often carried in a characteristic forward curve over the back, ending with a venomous stinger. Scorpions range in size from 9 mm (Typhlochactas mitchelli) to 21 cm (Hadogenes troglodytes). Scorpions are nocturnal; they prefer to be active during the night. They have poor eyesight yet thrive in the dark relying on their strong body, pinchers and stinger as a way to both defend and navigate any hostile environment.

Scorpions are found widely distributed over all continents, except Antarctica, in a variety of terrestrial habitats except the high latitude tundra. Scorpions' number about 1752 described species, with thirteen extant families recognized to date. The taxonomy has undergone changes and is likely to change further, as a number of genetic studies are bringing forth new information. Though the scorpion has a fearsome reputation as venomous, only about 25 species have venom capable of killing a human being. The body of a scorpion is divided into three parts (tagmata): the head (cephalothorax), the abdomen (mesosoma) and the tail (metasoma).

Bark Scorpion
The bark scorpion is found throughout Arizona, in the extreme southeastern portion of California near Arizona, and in southwestern New Mexico. Bark scorpions reach a length of 3 inches and have a very thin tail only 1/16 inch wide; the body is yellow without stripes or patterns. The bark scorpion is the only common climbing scorpion and does not normally burrow, but usually lives above ground under tree bark and in palm trees and crevices of rocky cliffs. Because it can ascend slump block walls or stucco, this species is the scorpion most likely to enter dwellings. The bark scorpion is attracted to moisture around homes and in the house. It also may be found in stacked lumber or bricks, firewood piles, cellars, and attics. It needs only a crack of 1/16 inch to enter a home.

Arizona Hairy Scorpion
The Arizona hairy scorpion, Hadrurus arizonensis, is a common desert species found in southern California and throughout Arizona. At maturity it can be 5 to 7 inches in length. Like many other desert scorpions, the Arizona hairy scorpion is a burrower, but may also be found under rocks, logs, sleeping bags, and other surface objects. This scorpion can often be found around homes and in garages. It is a night feeder attracted to water, swimming pools, irrigated areas, or outside lights where food prey such as beetles, cockroaches, crickets, moths, and other insects are attracted as well. During the day it may be found in woodpiles, palm trees, and decorative bark, or under loose boards, woodpiles, rocks, or the bark of trees. Like some other scorpions, the Arizona hairy scorpion may enter homes in search of water. Common indoor places where it might be found are dark, cool areas in the bathroom or kitchen as well as crawl spaces, attics, and closets.

Stripedtail Scorpion
The stripedtail scorpion, Vaejovis spinigerus, is one of the most common scorpion species in southern California, Arizona, and the United States. It is a burrowing scorpion that is often found in sandy soil but can survive in a variety of habitats, from desert floor to rocky hillside. At maturity, the stripedtail scorpion is about 2-1/2 inches long and the body is striped on the upper side. This scorpion is venomous, but not considered dangerous. It may be found under common objects such as sleeping bags, shoes, and other similar items.

Scorpion Biology
Scorpions have a three part body comprised of the cephalothorax (head), their main body or trunk which has 7 segments and their tail, which has 6 segments. The last segment of their tail works like a universal joint with a stinger attached. Scorpions are able to maneuver their tail in any direction and though most people think of them stinging in the classic "C" position with stinger over their head, scorpions will sting anyway possible when danger is present. Scorpions have 8 legs along with a set of pinchers up front which are quite strong and agile. They use these pinchers for hunting their prey, self-defense, grooming and maintaining their young.

Cephalothorax
The cephalothorax, also called the prosoma, comprises the carapace, eyes, chelicerae (mouth parts), pedipalps (commonly called claws, pincers or chelae) and four pairs of walking legs. The scorpion's exoskeleton is thick and durable, providing good protection from predators. Scorpions have two eyes on the top of the cephalothorax, and usually two to five pairs of eyes along the front corners of the cephalothorax The position of the eyes on the cephalothorax depends in part on the hardness or softness of the soil upon which they spend their lives. The pedipalp is a segmented, chelate (clawed) appendage used for prey immobilization, defense, and sensory purposes. The segments of the pedipalp (from closest to the body outwards) are coxa, trochanter, femur (humerus), patella, tibia (including the fixed claw and the manus) and tarsus (moveable claw).A scorpion has darkened or granular raised linear ridges, called "keels" or carinae on the pedipalp segments and on other parts of the body which are useful taxonomically.

Mesosoma
The abdomen, also called the opisthosoma, consists of seven segments (somites), each covered dorsally by a sclerotosed plate (tergum) and also ventrally for segments 3 to 7. The first abdominal segment bears a pair of genital opercula which cover the gonopore. Segment 2 consists of the basal plate with the pectines. Each of the mesosomal segments 3 to 7 have a pair of spiracles which are the openings for the scorpion's respiratory organs, known as book lungs. The spiracle openings may be slits, circular, elliptical, or oval.

Metasoma
The metasoma, the scorpion's tail, comprises five caudal segments (the first tail segment looks like a last mesosoman segment), and sixth bearing the telson (the sting). The telson, in turn, consists of the vesicle, which holds a pair of venom glands, and the hypodermic aculeus, the venom-injecting barb. On rare occasions, scorpions can be born with two metasomata (tails). Two-tailed scorpions are not a different species, merely a genetic abnormality.

Scorpion Habits
Scorpions are nocturnal, predatory animals that feed on a variety of insects, spiders, centipedes, and other scorpions. The larger scorpions occasionally feed on vertebrates, such as smaller lizards, snakes, and mice. Prey is located primarily by sensing vibrations. Although scorpions are equipped with venom to defend themselves, scorpions fall prey to many types

of creatures, such as centipedes, tarantulas, insectivorous lizards, birds (especially owls), and mammals (including shrews, grasshopper mice, bats). Scorpions feed mainly on insects and spiders and can survive without feeding for six months. During the day scorpions hide under stones, in piles of rocks, in cracks in masonry, in wood piles and under the bark of trees. Scorpions enter structures seeking water and shelter

Fluorescence
Scorpions are also known to glow when exposed to certain wavelengths of ultraviolet light such as that produced by a blacklight, due to the presence of fluorescent chemicals in the cuticle. One fluorescent component is now known to be beta-carboline. A hand-held UV lamp has long been a standard tool for nocturnal field surveys of these animals. Fluorescence occurs as a result of sclerotization and increases in intensity with each successive instar.

Scorpion Lifespan
Scorpions have quite variable lifespans and the actual lifespan of most species is not known. The age range appears to be approximately 4–25 years (25 years being the maximum reported life span in the species Hadrurus arizonensis). Lifespan of Hadogenes species in the wild is estimated at 25–30 years.

Scorpions prefer to live in areas where the temperatures range from 20 °C to 37 °C (68 °F to 99 °F), but may survive freezing temperatures to the desert heat. Scorpions of the genus Scorpiops living in high Asian mountains, bothriurid scorpions from Patagonia and small Euscorpius scorpions from Central Europe can all survive winter temperatures of about 25 °C (13 °F). In Repetek (Turkmenistan), there live seven species of scorpions (of which Pectinibuthus birulai is endemic) in temperatures which vary from –31 °C to 50 °C.

They are nocturnal and fossorial, finding shelter during the day in the relative cool of underground holes or undersides of rocks and coming out at night to hunt and feed. Scorpions exhibit photophobic behavior, primarily to evade detection by their predators such as birds, centipedes, lizards, mice, possums, and rats.

Scorpions can consume huge amounts of food at one sitting. They have a very efficient food storage organ and a very low metabolic rate combined with a relatively inactive lifestyle. This enables scorpions to survive long periods when deprived of food; some are able to survive 6 to 12 months of starvation. Scorpions excrete very little; their waste consists mostly of insoluble nitrogenous waste such as xanthine, guanine and uric acid.

Reproduction
The mother scorpion produces an average of 30 living young per brood which she carries on her back for up to 15 days. It takes up to four years for most species to reach maturity. Scorpions are predators, feeding mainly on insects and spiders. They can survive without feeding for many months.

Most scorpions reproduce sexually, and most species have male and female individuals.
However, some species, such as Hottentotta hottentotta, Hottentotta caboverdensis, Liocheles australasiae, Tityus columbianus, Tityus metuendus, Tityus serrulatus, Tityus stigmurus, Tityus trivittatus, and Tityus urugayensis, reproduce through parthenogenesis, a process in which unfertilized eggs develop into living embryos. Parthenogenic reproduction starts following the scorpion's final molt to maturity and continues thereafter.

Sexual reproduction is accomplished by the transfer of a spermatophore from the male to the female; scorpions possess a complex courtship and mating ritual to affect this transfer. Mating starts with the male and female locating and identifying each other using a mixture of pheromones and vibrational communication. Once they have satisfied the other that they are of opposite sex and of the correct species, mating can commence.

Courtship

The courtship starts with the male grasping the female's pedipalps with his own; the pair then performs a "dance" called the "*promenade à deux*". In reality this is the male leading the female around searching for a suitable place to deposit his spermatophore.

The courtship ritual can involve several other behaviors such as juddering and a cheliceral kiss, in which the male's chelicerae – claw like mouthparts – grasp the female's in a smaller more intimate version of the male's grasping the female's pedipalps and in some cases injecting a small amount of his venom into her pedipalp or on the edge of her cephalothorax, probably as a means of pacifying the female.

When the male has identified a suitable location, he deposits the spermatophore and then guides the female over it. This allows the spermatophore to enter her genital opercula, which triggers release of the sperm, thus fertilizing the female. The mating process can take from 1 to 25+ hours and depends on the ability of the male to find a suitable place to deposit his spermatophore.

If mating goes on for too long, the female may eventually lose interest, breaking off the process. Once the mating is complete, the male and female will separate. The male will generally retreat quickly, most likely to avoid being cannibalized by the female, although sexual cannibalism is infrequent with scorpions.

Birth and Development

Scorpions are viviparous. The young are born one by one, and the brood is carried about on its mother's back until the young have undergone at least one molt. Before the first molt, scorplings cannot survive naturally without the mother, since they depend on her for protection and to regulate their moisture levels. Especially in species which display more advanced sociability (e.g. Pandinus spp.), the young/mother association can continue for an extended period of time. The size of the litter depends on the species and environmental factors, and can range from two to over a hundred scorplings. The average litter however, consists of around 8 scorplings.

The young generally resemble their parents. Growth is accomplished by periodic shedding of the exoskeleton (ecdysis). A scorpion's developmental progress is measured in instars (how many molts it has undergone). Scorpions typically require between five and seven molts to reach maturity. Molting commences with a split in the old exoskeleton just below the edge of the carapace (at the front of the prosoma). The scorpion then emerges from this split; the pedipalps and legs are first removed from the old exoskeleton, followed eventually by the metasoma.

When it emerges, the scorpion's new exoskeleton is soft, making the scorpion highly vulnerable to attack. The scorpion must constantly stretch while the new exoskeleton hardens to ensure that it can move when the hardening is complete. The process of hardening is called sclerotization. The new exoskeleton does not fluoresce; as sclerotization occurs, the fluorescence gradually returns.

Relationship with Humans
Certain species of scorpion are aggressive and will attack humans with little to no provocation, while others will only attack when threatened.

Scorpion Sting and Venom
All known scorpion species possess venom and use it primarily to kill or paralyze their prey so that it can be eaten; in general, it is fast-acting, allowing for effective prey capture. It is also used as a defense against predators. The venom is a mixture of compounds (neurotoxins, enzyme inhibitors, etc.) each not only causing a different effect, but possibly also targeting a specific animal. Each compound is made and stored in a pair of glandular sacs and is released in a quantity regulated by the scorpion itself. Of the 1000+ known species of scorpion, only 25 have venom that is dangerous to humans; most belong to the family Buthidae.

First Aid
First aid for scorpion stings is generally symptomatic. It includes strong analgesia, either systemic (opiates or paracetamol) or locally applied (such as a cold compress). Hypertensive crises are treated with anxiolytics and vasodilators.

Medical Use
The key ingredient of the venom is a scorpion toxin protein. Short chain scorpion toxins constitute the largest group of potassium (K+) channel blocking peptides; an important physiological role of the KCNA3 channel, also known as KV1.3, is to help maintain large electrical gradients for the sustained transport of ions such as Ca2+ that controls T lymphocyte (T cell) proliferation. Thus KV1.3 blockers could be potential immunosuppressants for the treatment of autoimmune disorders (such as rheumatoid arthritis, inflammatory bowel disease and multiple sclerosis). The venom of Uroplectes lineatus is clinically important in dermatology.

Toxins being Investigated include:

- Chlorotoxin is a 36-amino acid peptide found in the venom of the deathstalker scorpion (Leiurus quinquestriatus) which blocks small-conductance chloride channels. The fact that chlorotoxin binds preferentially to glioma cells has allowed the development of new methods, that still are under investigation, for the treatment and diagnosis of several types of cancer.

- Maurotoxin from the venom of the Tunisian Scorpio maurus palmatus

Control of Scorpions
Sanitation is the first step in scorpion control. Loose boards, wood piles, rocks, and debris should be eliminated from areas around the home, especially near foundation walls. Spray an excellent residual insecticide in these areas. This will also reduce populations of insects that the scorpions feed on. Spray a swath outside approximately six feet around the perimeter of the home and one foot up the foundation wall.

Spray all entry points from the inside. We recommend using Suspend SC. Use a Chapin pump-up type sprayer for application. Both are excellent insecticides. Use Delta Dust to treat the electrical outlets, attic spaces and around the plumbing and electrical fixtures. Use a Hand Duster for application of the dust. Always wear Gloves and a Dust mask. Scorpion infestations can be effectively controlled with thorough applications of the above insecticides into cracks and crevices and other potential harborage areas.

Scorpions present a hazard both in the yard and in the home. They love to reside where it is moist and irrigated lawns and landscaping will naturally attract them. It is thought they are coming for the other insects on which to feed but regardless of why they come around, once they're found in the grass and turf some will undoubtedly find their way inside.

For this reason, it is important that you address outside populations on a regular or maintenance type program. As is the case with many perimeter invading pests, by keeping outside populations in check, you can dramatically reduce the risk of any getting inside local structures. This will help to reduce contact with people which in turn will help to minimize the chance of anyone getting stung.

Scorpion Pesticide and Chemical Treatments

Scorpions and Spiders may be the toughest of all the insects to kill. Fumigation will kill living scorpions and spiders, but unless you kill every last one of them, you still have the problem. Scorpions arrive for food. If you get rid of the food, then they go away. Fill up bathtubs and sinks with water and flush them on a regular basis. Scorpions tend to come up the drainage system at night. Also they make have to put up screens on A/C ducts as well if above method does not get rid of them.

Scorpions can be controlled with pesticides, but because of the scorpions' cryptic nature, it is difficult to deliver the pesticide directly. Residual pesticides, i.e., pesticides that last a long time after application, provide a means of "indirect fire" against the scorpions. Residual pesticides should be applied to the yard and exterior of the home, paying special attention to structures that provide harborage (stone walls, etc.) and potential entry points around the home. Pesticide application must be done on a regular basis, the interval of which will be determined by the severity of the infestation and the success of your cultural and mechanical control methods. This type of pesticide application can only be done by a certified pest control operator, so consult your local pest control company for more information. Although an important part of the overall control strategy, chemical control is the one most fraught with problems. It is expensive, temporary (needs to be repeated), and environmentally and medically hazardous.

Scorpion Outside Treatments

Around the home, scorpions love to nest in flower beds, mulch piles, under wood chips or pine straw and in garages which store a lot of boxes or other items on the floor. The scorpion's flat body lends itself well to being able to crawl under most any object. This ability to crawl into small cracks and crevices is what makes the scorpion a common invader to our living environments.

They are great climbers and will readily scale brick, wood, stucco and most any siding on a house so if you let them live around the home, some will invariably move inside. They do this seeking both warmth and refuge and once inside, will require extensive treatments to exterminate established populations.

Deltamethrin Granules

Treating them outside is both easier and less costly and should be done on a regular basis if you reside where scorpions are present. There are two types of preventive maintenance which should be done around the home. First, apply Deltamethrin Granules around the home quarterly.

The most minimal treatment needed is to disperse the granules around all sides of the home effectively establishing a "band" of treated turf. This treated band will stop scorpions from both nesting and crawling thus keeping them out of the home. Use a granule spreader when doing the application to insure uniform application. These granules pose no hazard to people or pets when applied properly and will last 2-3 months per treatment. Be sure to treat at least a 10-foot-wide area around the structure. This amount of coverage will give you adequate protection. If you are in an area which borders on woods, fields or other turf which has a high amount of scorpions present, treat as much of the yard as possible. Getting this area blanketed will cut down and all but eliminate scorpions from nesting and foraging. This will enable you to have both pets and children use the area with minimal risk of getting stung. Since the Deltamethrin Granules are slow acting and need a week or so to "kick in", the use of a liquid material over the turf will be needed if you want immediate knockdown.

Cykick CS

Cykick CS is an excellent material for this type of application. Use it in a 20-gallon hose end sprayer. This is the type of sprayer that connects to your garden hose. Just add some water and Cykick CS, attach it to your garden hose and spray away. Getting the local turf, flower beds and mulch areas soaked will insure you penetrate down where scorpions like to hide. Be sure to spray the sides of the home with it as well.

Direct the spray at the foot of the foundation and come up at least 3 feet. Since scorpions will regularly climb up just about any building, treating the side of the home is important and should be done a regular basis.

Just keep children and pets away when the application is done but they will be able to safely access the treatment sights once all areas are dry. This will usually be within an hour of the application. If you have just a small area to treat, you could opt to use a pump sprayer for the job. Just remember that the key when spraying over flat areas for scorpions is being sure to use enough water.

The bottom line here is being sure to get the right amount of Cykick out for the area you want to treat. Using a lot of water won't hurt; in fact, more water is better at dispersing the Cykick down into the key areas where scorpions like hide.

Inside Treatment

Anyone with current nesting and scorpions' active in the home should be taking a lot of precautions to insure occupants don't get stung. Be especially careful at night when walking around. Since scorpions are nocturnal, it is highly likely that you will encounter them when it is dark. Try to wear slippers, sandals or some other footwear to minimize the possibility of being stung when walking around.

Stepping on a scorpion is one of the more common ways people get stung so be careful at night!
If you see scorpions on a regular basis in the home during the night, get a black light to help identify where they are located. Scorpions reflect the light making them very visible and easy to see.

Recommended Measures for Scorpion Control:

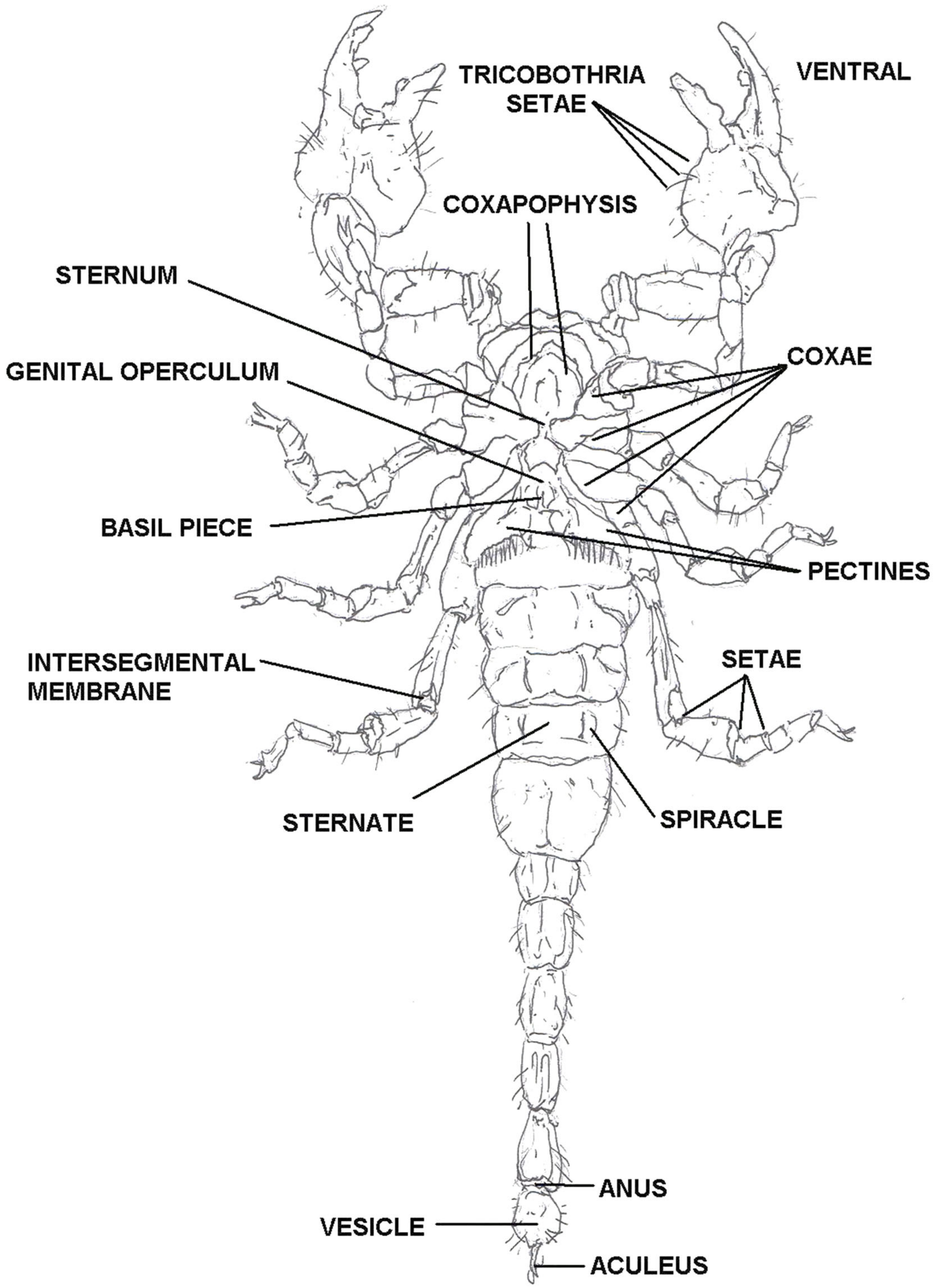
1. Remove outdoor harborages e.g. piles of trash, stones, boards, firewood on the ground and the landscape timbers, should be removed.

2. Points of entry into buildings, e.g. siding, windows, doors, pipes and wires, should be sealed.

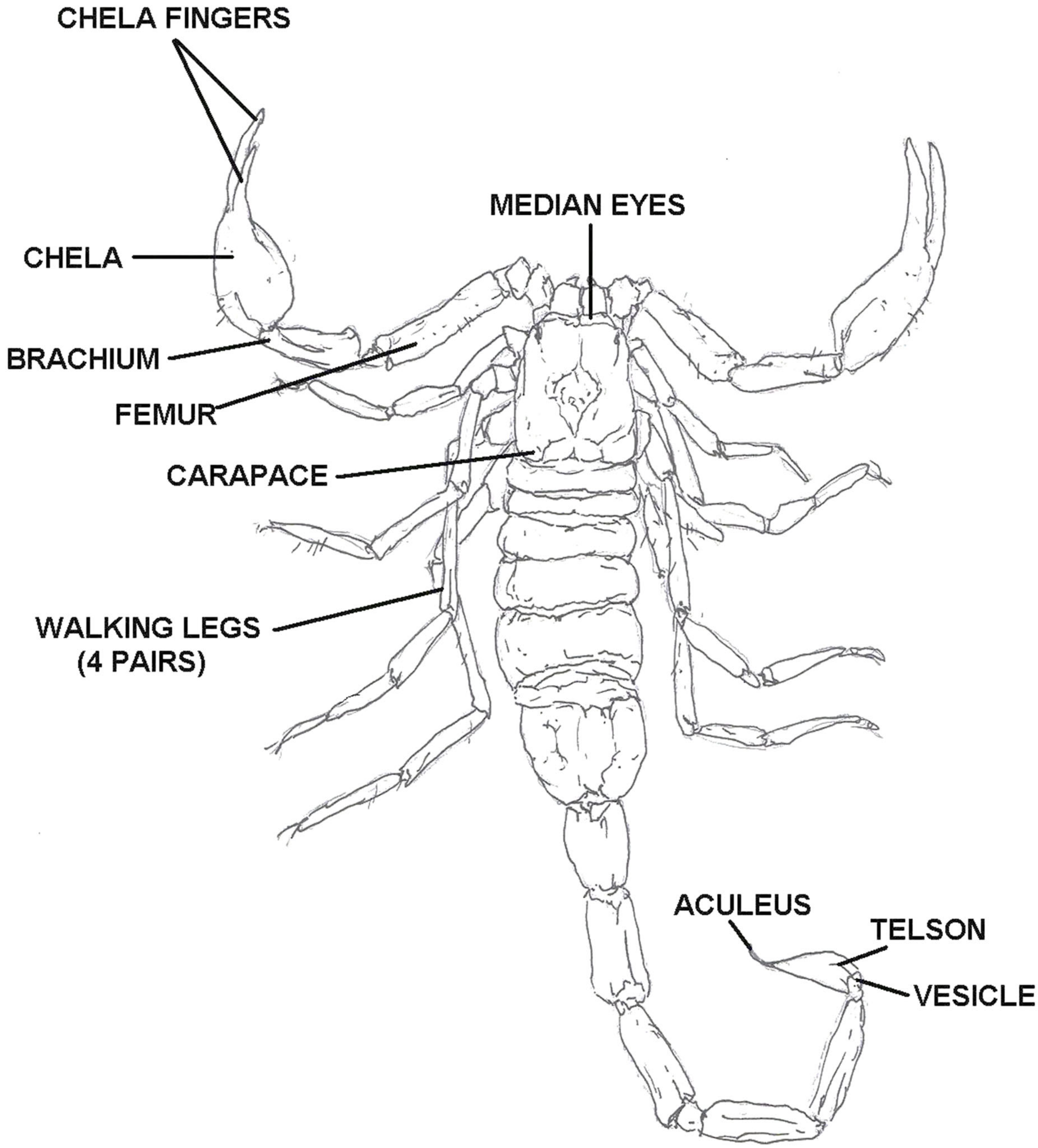
3. The use of a residual insecticide such as the wettable powders (WP**).**
Demon WP or Cyper WP should be applied as a 3- to 10-foot band around the perimeter of the structure, into harborage sites, and/or around potential entry points, such as: around all windows and doors, along baseboards, plumbing, inside closets, and garage and basement areas. Both Demon WP and Cyper WP are wettable powders that may leave a visible residue that can be seen against dark surfaces.

The next best alternative would be:
Cyonara 9.7 or Suspend SC.
These products would last just as long and cannot not be seen against dark surfaces. However, wettable powders work better against scorpions.
4. The use of dusts:
Drione Dust or Delta Dust should be used in the attic area if that is source of entry.

BARK SCORPION



SCORPION ANATOMY (UNDERSIDE)



SCORPION ANATOMY (DORSAL VIEW)

Spider Identification Section

Fill-in-the blank

Two Primary Spider Groups
1. ______________construct webs in rather quiet, undisturbed places to capture their food. They live in or near their web and wait for food to come to them. They generally have poor eyesight and rely on sensing vibrations in their web to detect prey.

Jumping Spiders
2. Jumping spiders are generally small to medium-sized (about 1/5 - 1/2 inch long) and compact-looking. They are usually dark-colored with white markings, although some can be brightly colored, including some with________________.

Purseweb Spiders (Sphodros genus, Atypidae family, Mygalomorphae suborder)
3. _____________are generally large spiders; though they seem to be the species most likely to inspire arachnophobia, all of the US species are harmless to humans.

Black Widow Spider
4. The female black widow spider ______________her web. The web she constructs is an irregular, tangled, crisscross web of rather coarse silk. The core of the web is almost funnel shaped, woven into a silken tunnel in which the female spider spends the majority of her daylight hours.

Brown Recluse Spider
5. The most definitive physical feature of recluse spiders is their eyes: most spiders have eight eyes that typically are arranged in two rows of four, but recluse spiders have six equal-sized eyes arranged in three pairs, called dyads. There is a _____________at the front of the cephalothorax (the first main body part to which the legs attach) and another dyad on each side, further back.

6. A female deposits eggs in off-white silken cases about 1/3 inch in diameter in sheltered, dark areas. Spiderlings emerge in______________and abandon the egg case.

7. Almost all species of Mygalomorphae have eight eyes, however there are some with fewer (Masteria lewisi has only six eyes). They have ______________that lie entirely within their chelicerae, but only spiders of the Australian genus Atrax can be really harmful to humans. Their chelicerae and fangs are large and powerful.

8. Occasionally members of this suborder will even kill small fish, small mammals, and the like. While the ______________are mygalomorphs - Theraphosa blondi has a body length of 10 cm, and a leg span of 28 cm - some species are less than one millimeter long.

9. Mygalomorphae can live for up to___________________, and some don't reach maturity until they are about six years old. Some flies in the family Acroceridae which are endoparasites of mygalomorphs may remain dormant in the book lungs for as long as 20 years before beginning their development and consuming the spider.

Vinegarroons

10. Vinegarroons have___________________, but they do have glands near the rear of their abdomen that can spray a combination of acetic acid and octanoic acid when they are bothered. The acetic acid gives this spray a vinegar-like smell, giving rise to the common name vinegarroon.

Spider Identification Section Post Quiz Answers

1. Web-building spiders, 2. Iridescent mouthparts, 3. Mygalomorphs, 4. Rarely leaves, 5. Dyad, 6. 24-36 days, 7. Ample venom glands, 8. World's biggest spiders, 9. 25 years, 10. No venom glands

Topic 11 - Web Spider Section

Section Focus: You will learn the basics of the web weaving spiders. At the end of this section, you will be able to understand and describe various web weaving spiders. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Spider identification is difficult even for experts. There are about 3,700 species of spiders in North America alone, and there are no doubt many "new" species awaiting descriptions and names from scientists. The characters needed to identify a spider, like the arrangement of its eyes, are often not visible in images. It is helpful, however, to note the kind of web you found the spider in (not all spiders spin webs, though), whether it was outdoors or indoors, and include an accurate assessment of the size of the spider (body length or legspan). Always remember to include a specific geographic location in your post. Lastly, make sure it is actually a spider that you have, and not another arachnid, or even an insect.

CELLAR SPIDER (NOT HARVESTMAN)

Cellar Spiders
Cellar spiders have long, thin legs and build sheet-like or irregular webs in dark places. They commonly hang upside down under the web.

COMB FOOTED SPIDER

Comb-footed Spiders
Also known as cobweb spiders, are very common spiders outdoors and indoors. They are small to medium-sized spiders (about 1/8 - 3/8 inch long). Comb-footed spiders are usually brownish or grayish. They build irregular webs in many places, including wood and stone piles and in quiet areas of buildings, such as basements. A common type of comb-footed spider found indoors is the house spider. It is grayish to brownish with chevron-like markings on its abdomen and a body length of over 1/4 inch.

FUNNEL WEB WEAVER

Funnel Web Weavers
Funnel web weavers (Family Agelenidae) are small to medium sized spiders often found in grassy fields, low shrubbery, or living among leaf litter in forests. They spin sheet webs of non-sticky silk with a characteristic funnel extending off to one side.

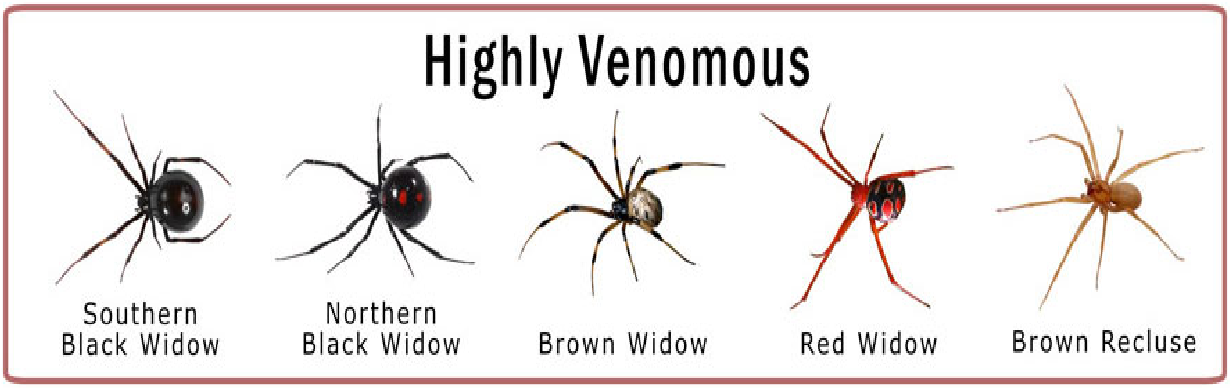
The funnel is where the spider hides while awaiting prey. There is a 3-dimensional barrier web spun above the sheet web, and when a prey item falls through onto the sheet web, the spider quickly runs out and bites its victim, then drags it back to the funnel to feed. These sheet webs are nearly invisible unless covered with dewdrops on a cool morning, and the spider can move very quickly over the surface. It almost looks as if the spider is walking on air. There are over 500 North American species. Spiders in the most common genus, Agelenopsis, are commonly called "grass spiders," after their habit of building their combination sheet-and-funnel webs in grass and low shrubs.

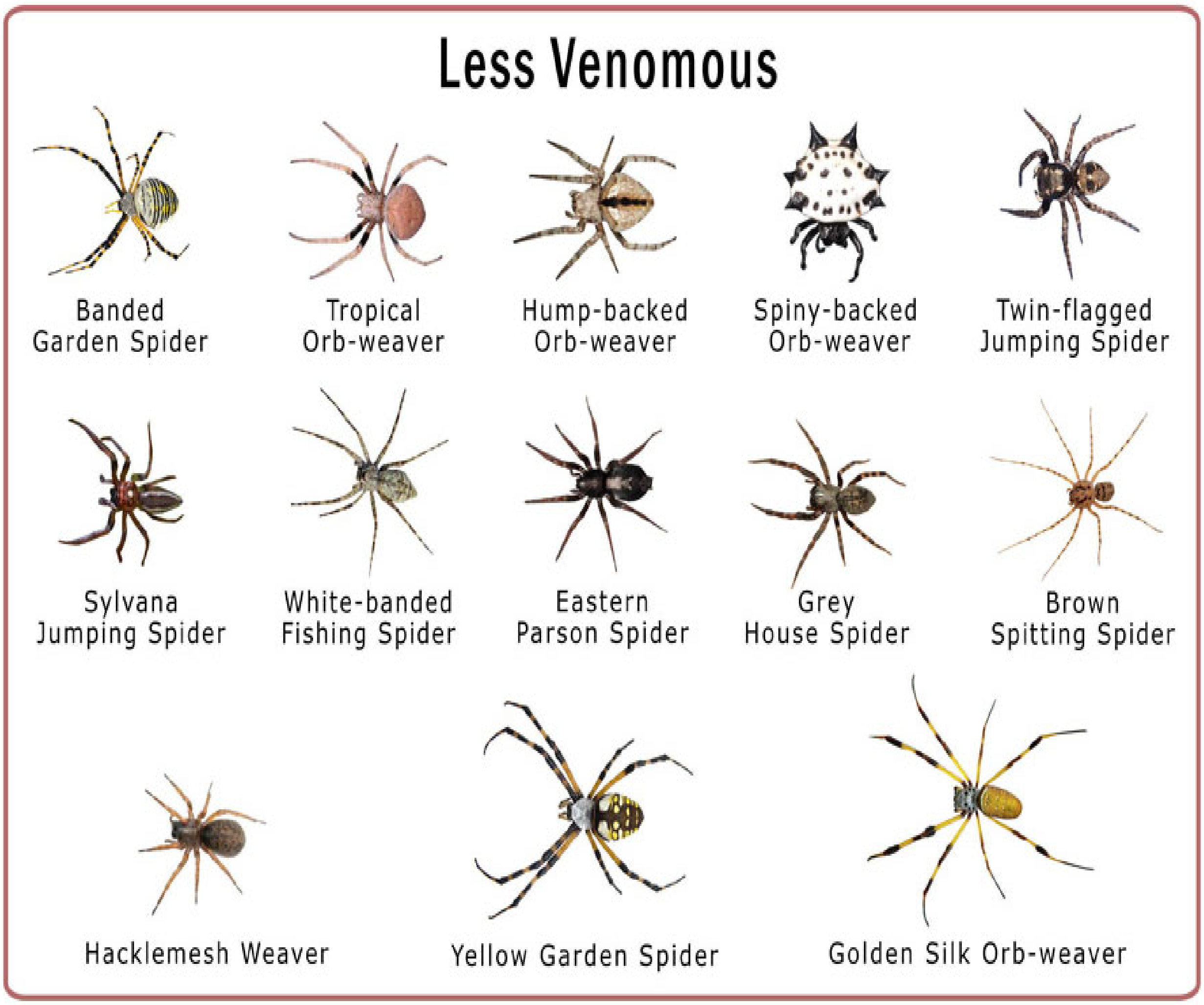
Venom toxicity - the bite of these spiders is of low risk to humans.

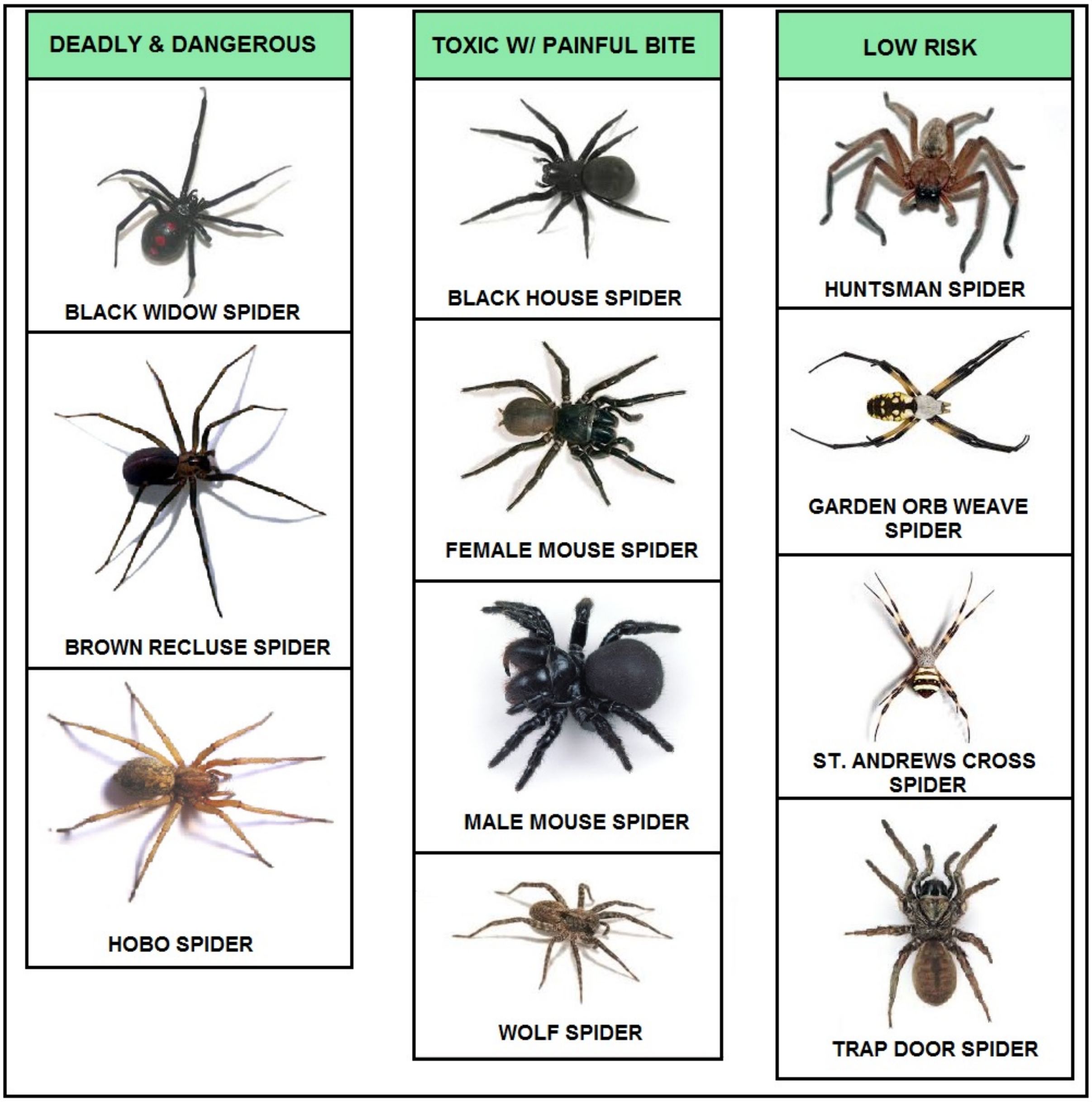
Spider Identification - are common outdoors and are occasionally found indoors. They are generally brownish or grayish with light and dark stripes near the head. They have long spinnerets and are moderate-sized (3/4 inch long). Grass spiders construct a large sheet web with a funnel they use as a retreat. These webs are commonly built on the ground, around steps, window wells, foundations, and low shrubs.

Habitat - These spiders are often called grass spiders because they construct their webs in tall grass, heavy ground cover and the branches of thick shrubs. Rarely will a funnel web spider be seen indoors, except for an occasional wandering male. They are found mostly in the Pacific Northwest states.

GRASS SPIDER


Highly Venomous
Southern Black Widow
Northern Black Widow
Brown Widow
Red Widow
Brown Recluse


Less Venomous
Banded Garden Spider
Tropical Orb-weaver
Hump-backed Orb-weaver
Spiny-backed Orb-weaver
Twin-flagged Jumping Spider
Sylvana Jumping Spider
White-banded Fishing Spider
Eastern Parson Spider
Grey House Spider
Brown Spitting Spider
Hacklemesh Weaver
Yellow Garden Spider
Golden Silk Orb-weaver



COMMON US SPIDERS

Grass Spiders
A type of funnel weaver, are common outdoors and are occasionally found indoors. They are generally brownish or grayish with light and dark stripes near the head. They have long spinnerets and are moderate-sized (3/4 inch long). Grass spiders construct a large sheet web with a funnel they use as a retreat. These webs are commonly built on the ground, around steps, window wells, foundations, and low shrubs.

MARBLED ORB SPIDER

Orb Spiders – Human Biters
Are common spiders outdoors near buildings, but are usually not found indoors. They range in size from small to large (1/8 - 1 inch long) and are found in a variety of colors, with some being brightly colored. Orb spiders have large, swollen-looking abdomens, including some that are oddly shaped. They make the classic round, flat, wheel-like web familiar to most people.

BLACK AND YELLOW ARGIOPER

The black and yellow argioper, also known as the garden spider, is familiar to many. It is large (up to 1 inch long) and brightly colored black and yellow. Another common orb spider is the barn spider. It is large (4/5 inch long) and brownish in color.

Orb Weaving Spiders
Orb weavers (Family Araneidae) comprise a huge family of spiders, of which there are several hundred species in North America. These spiders vary greatly in color, shape and size, measuring between 2 - 30mm (1/16 -- 1 1/4") long. They have eight eyes arranged in two horizontal rows of four eyes each. The males are generally much smaller than the females and commonly lack the showy coloring of their fairer sex. They often spin their own smaller orb web near an outlying portion of the female's, and I've noticed most males give the females wide berth. Indeed, I rarely see male orb weavers, they are so reclusive.

Venom toxicity - the bite of Orb-Weaving Spiders is of low risk (not toxic) to humans. They are a non-aggressive group of spiders, seldom bite. Be careful not to walk into their webs at night - the fright of this spider crawling over one's face can be terrifying and may cause a heart attack, particularly to the susceptible over 40 year olds.

Spider Identification - an adult is about 2/3 to more than 1 inch in body length - has a bulbous abdomen - often colorful - dark to light brown pattern. The common Golden Orb-Weaver Spider has a purplish bulbous abdomen with fine hairs.

Habitat - often found in summer in garden areas around the home - they spin a large circular web of 6 feet or more, often between buildings and shrubs, to snare flying insects, such as, flies and mosquitoes.

MALE BLACK WIDOW SPIDER

Trap-Door Spiders – Human Biter

TRAP DOOR SPIDER SPECIES

Venom toxicity - the bite of the Trap-Door Spider is of low risk (non-toxic) to humans. It is a non-aggressive spider - usually timid but may stand up and present its fangs if harassed. Rarely bites - but if so it can be painful.

Spider Identification - an adult is about 1 and 1/2 inches in body length - brown to dark brown in color - heavily covered with fine hairs. The male has distinct boxing glove-shaped palps, that is, the two "sensory feelers" at front of its head.

Habitat - this spider is a ground dweller, with a burrow retreat lined with silk of up to 10 inches in depth and around 1 inch in width - prefers nesting in drier exposed locations - often has a wafer-like lid on the burrow entrance. Trap-Door Spiders are commonly found in the drier open ground areas around the home.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

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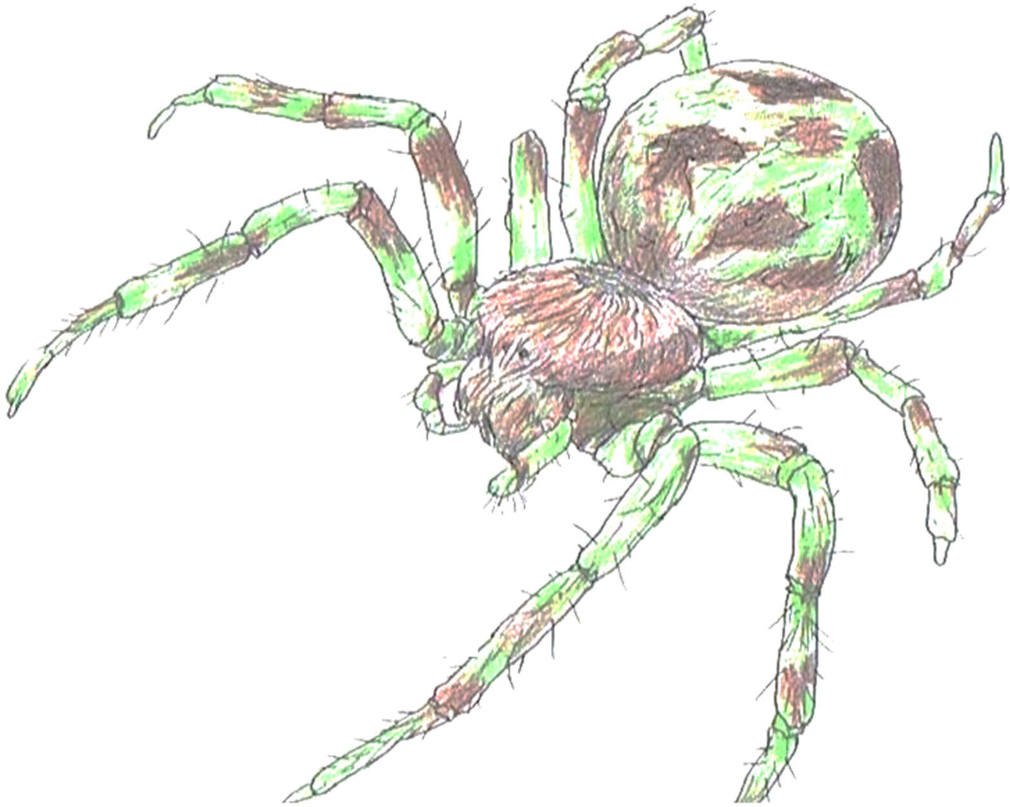
Neil Young Trap-door Spider

American rock icon Neil Young has had an honor bestowed upon him that is not received by many musicians – his own spider. Jason Bond, a biologist at East Carolina University, named a newly discovered arachnid, Myrmekiaphila neilyoungi. It is also known as a trapdoor spider.

Young isn't the first musician to have a new species named after him, which honor goes to Roy Orbison whose name graces the whirligig beetle. (Orectochilus orbisonorum)

House Spiders



AMERICAN HOUSE SPIDER
(ARANEUS DIADEMATUS)

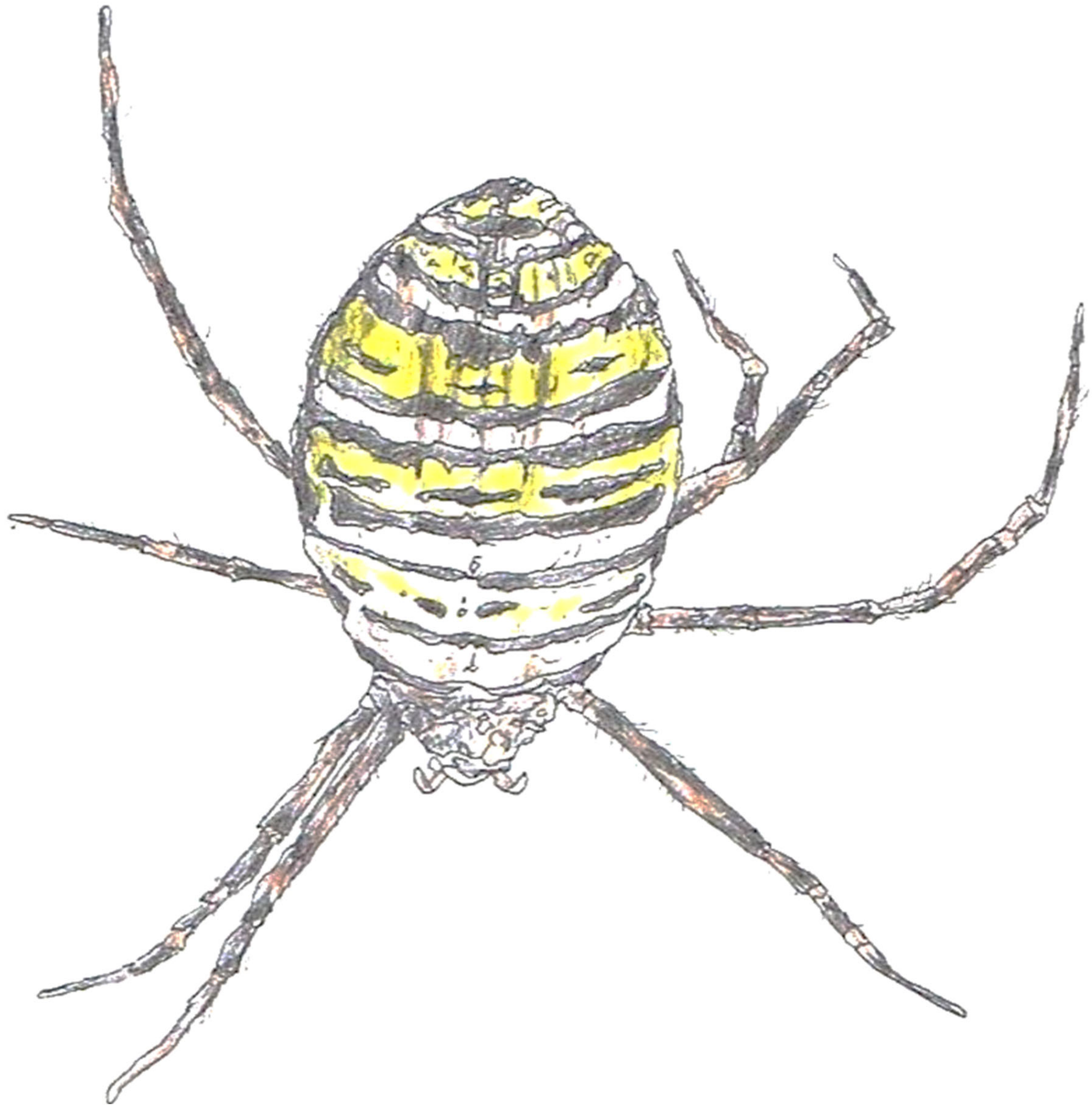
The common house spider belongs to the funnelweb spiders in the family Agelenidae in the suborder Araneomorphae. House spiders are found throughout Europe and North America. This spider is so named because its horizontal sheet web is often seen in wall corners of houses, but it can also be found in any cool, dark place, such as dense vegetation or crevices of logs or rocks. The spider's web forms a tube, and the narrowed end serves as a retreat where the spider can hide. When an insect walks over the sheet web, the spider immediately rushes out from the funnel, grabs its victim, and delivers a poisonous bite. The spider then carries its prey back to its retreat, where it begins to feed.

Sometimes house spiders leave their webs and can be seen wandering around or trapped in a bathtub. These are usually males who have given up building webs, but are always in search of a female. Male house spiders lack adhesive hairs on their feet, and therefore, cannot climb on smooth vertical surfaces, such as those found in sinks and bathtubs. Most house spiders are harmless and may actually prove beneficial to humans since they feed on insects that stray indoors.

Garden Spiders
Garden spiders belong to the family Araneidae, a group of 2,500 different species of spiders that weave orb, or circular, webs. Marked with varying shades of brown, garden spiders have a distinctive white cross on their abdomens, and some people refer to them as cross spiders.

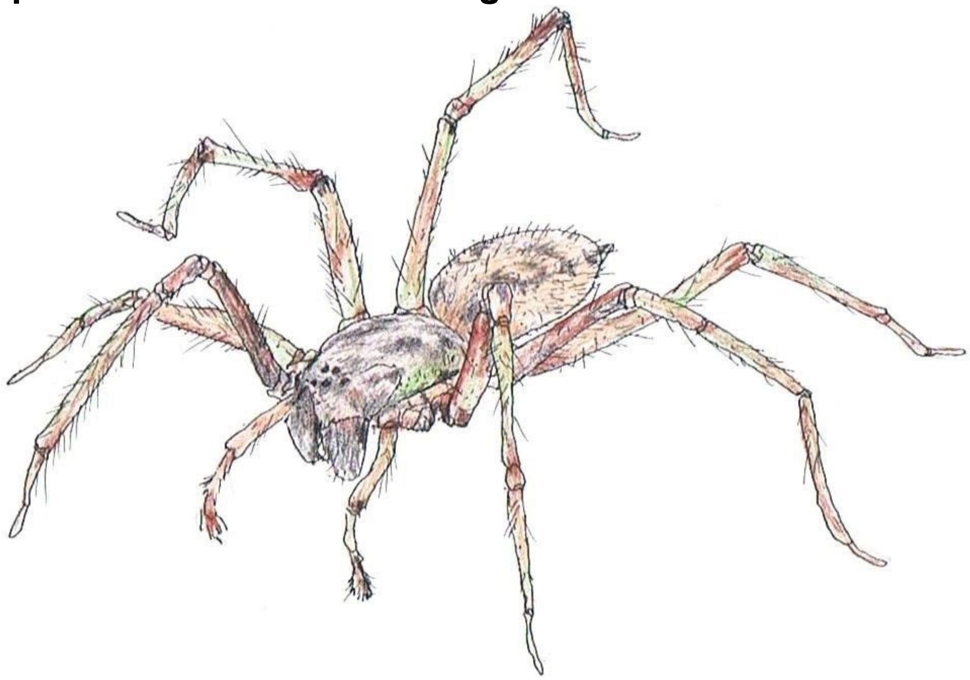
They are found throughout the continental United States, Canada, and Mexico. Some species are found in Europe and Hawaii.

Like most orb weavers, a garden spider typically sits upside down in the middle of the orb web, placing its eight feet on the threads radiating out from the center of the web. The feet act as sensors, picking up vibrations when prey enters the web. When an insect becomes stuck in the web's sticky spiral threads, the spider rushes out to wrap the victim with silk and give it a paralyzing bite. The spider then carries the prey back to the hub of the web to feed on it.



BANDED GARDEN SPIDER
(ARGIOPE TRIFASCIATA)

Hobo Spider – Human Biter – Dangerous/Venomous



HOBO SPIDER
(TEGENERIA AGRESTIA)

The hobo spider is a member of the funnel-web spider family Agelenidae. Funnel-web spiders are long-legged, swift-running spiders that build funnel or tube-shaped retreats. The hobo spider runs at an average speed of about 0.45 meters (17 inches) per second, with a maximum speed of about 1.1 meters (40 inches) per second. The hobo spider has a brown cephalothorax (the front portion to which the legs are attached) and brown legs, with darker markings on the cephalothorax. The abdomen has a distinctive pattern of yellowish markings on a grayish back ground, although this pattern can be difficult to discern without the aid of a microscope or hand lens. The pattern is generally more discernible in immature specimens. Unlike many other similar-looking spiders, hobo spiders do not have darker bands (like multiple arm bands) on their legs. Spiders with such banding can be assumed not to be hobo spiders.

Female Hobo Spider
The hobo spider is one of the most dangerously venomous spiders in the United States. The hobo's "stronghold territory" ranges from extreme southern Alaska through southern B.C. and Alberta, Canada, to central and southern California, and east into central Colorado. However, we have confirmed catches throughout the continental USA to the eastern seaboard and into all Gulf States, making the "hobo spider" a national pest.

The hobo spider, originating from Europe, began its infestation of the continental USA in the Port of Seattle some time before the 1930's. Most poisonous spider bites in the western half of the USA are due to the Hobo spider. A venomous bite from a Hobo or Brown Recluse Spider can be severe.

Necrotic arachnidism results from envenomation (venom poisoning) from the bite of Hobo, or Recluse. It occurs due to the venom's ability to clot blood which results in an area of tissue receiving inadequate blood flow and thus dying secondary to oxygen starvation.

Although the bite of the hobo spider is initially painless, the bite can be serious. After 24 hours, the bite develops into a blister and after 24-36 hours, the blister breaks open, leaving an open, oozing ulceration. Typically, when the venom is injected, the victim will experience an immediate redness, which develops around the bite.

The most common reported symptom is severe headache. Other symptoms can include nausea, weakness, fatigue, and temporary memory loss and vision impairment. In any case, first aid and medical attention should be sought, if bitten, as and when any adverse health effects are observed.

Spider Identification - they are brown in color and the adults measure roughly 1/3 to 2/3 inch in body length and 2/3 to 2 inches in leg span. Their abdomens have several chevron shaped markings. Males are distinctively different from females in that they have two large palpi (mouth parts) that look like boxing gloves. Females tend to have a larger and rounder abdomen when compared to males. Up to 50% of bites by dangerously venomous spiders are "dry," with no venom injected and no signs of poisoning developing.

Most people bitten and envenomated by Hobo or Recluse spiders do not feel the initial bite and do not see the biting spider. Bites that are more serious occur when the Hobo gets between clothes or bedding and skin and is trying to get away. Keeping clothes, bedding, and storage boxes off the floor is a wise precaution, since they are preferred hiding places for the Hobo. People often get bitten in bed, sleeping on couches or floors, when putting on clothes, coats, gloves or shoes that have been on the floor, and when picking up piles of laundry.

Seek medical attention if you think you have a Hobo or Brown Recluse spider bite. If possible, collect up the spider or what remains of it and take with you to your doctor or emergency clinic.

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Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned.

Mouse Spider- Human Biter- – Dangerous/Venomous Not in USA

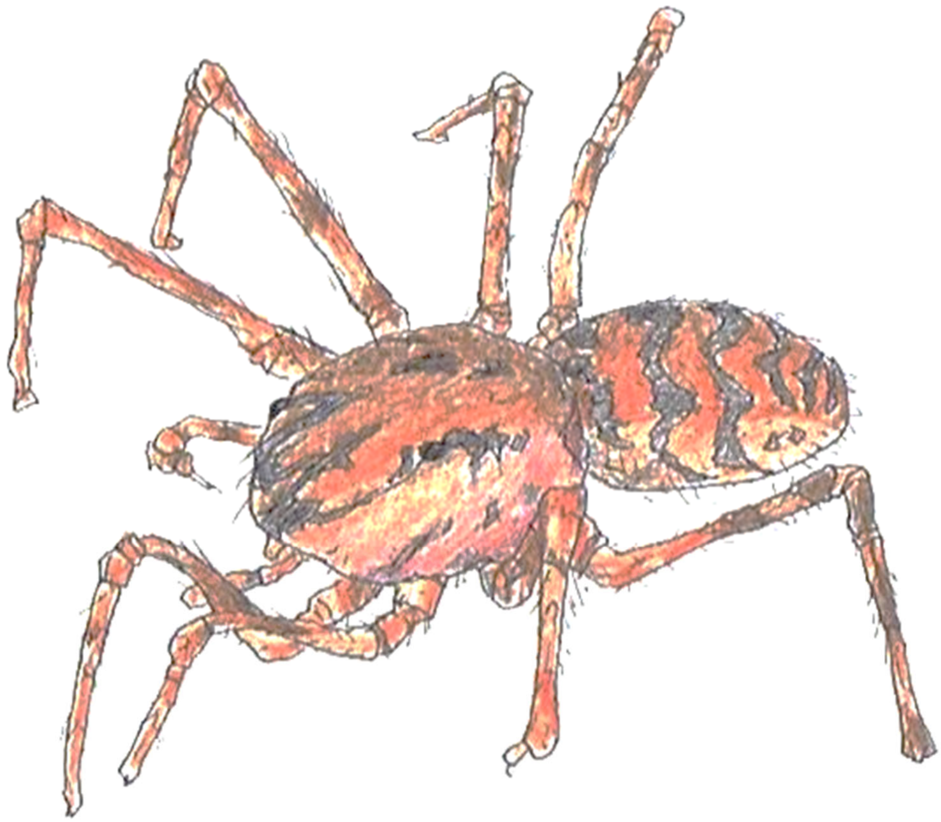
MOUSE SPIDER

Mouse Spiders are spiders of the genus Missulena. There are 11 known species in this genus, all but one of which are widespread across mainland Australia. Mouse Spiders can be found in both coastal and drier habitats, however, they do not occur in tropical rainforests. One species, Missulena tussulena, is found in Chile.

Mouse Spiders are a kind of Trapdoor spider and sometimes mistaken for Funnel Web spiders.

Mouse Spiders are medium to large spiders, which range in length from 1 centimeter to 3 centimeters. Female Mouse Spiders are usually 3 centimeters long whereas males are smaller at around 2 centimeters long.

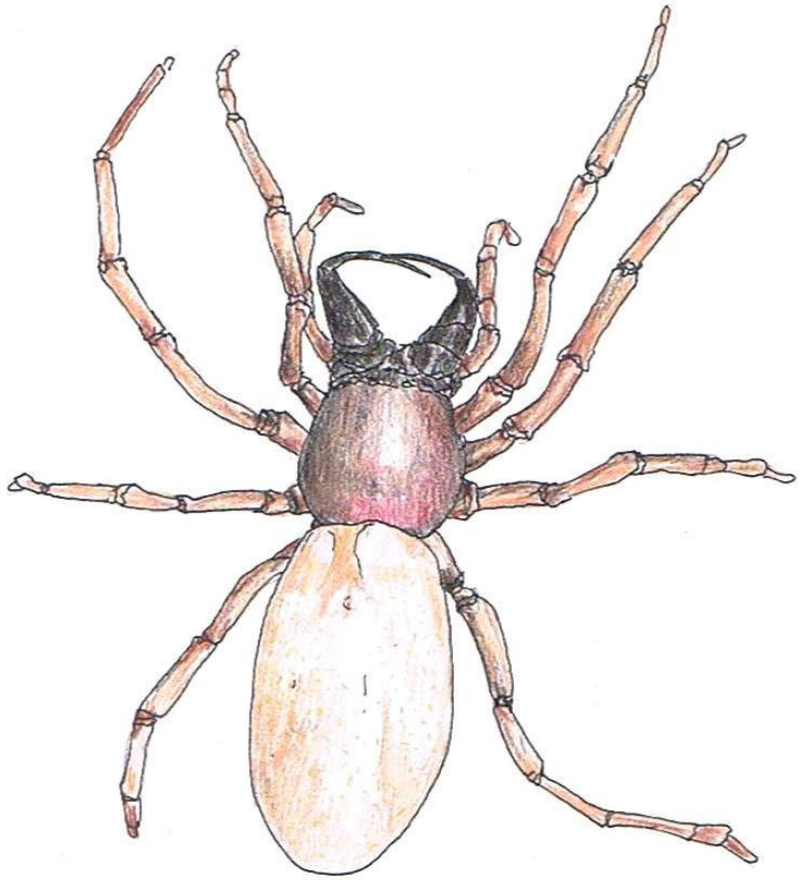
Six-Eyed Spiders



SPITTING SPIDER
(SCYTODES THORACICA)
An adult spitting spider with characteristic body coloration.

The spitting spiders (Scytodes spp.) are closely related to recluse spiders and have six eyes arranged in a similar pattern. However, they also have many black spots or lines on their bodies that would exclude them as recluses.

Seek medical attention if you think you have a spider bite. If possible, collect up the spider or what remains of it and take with you to your doctor or emergency clinic.



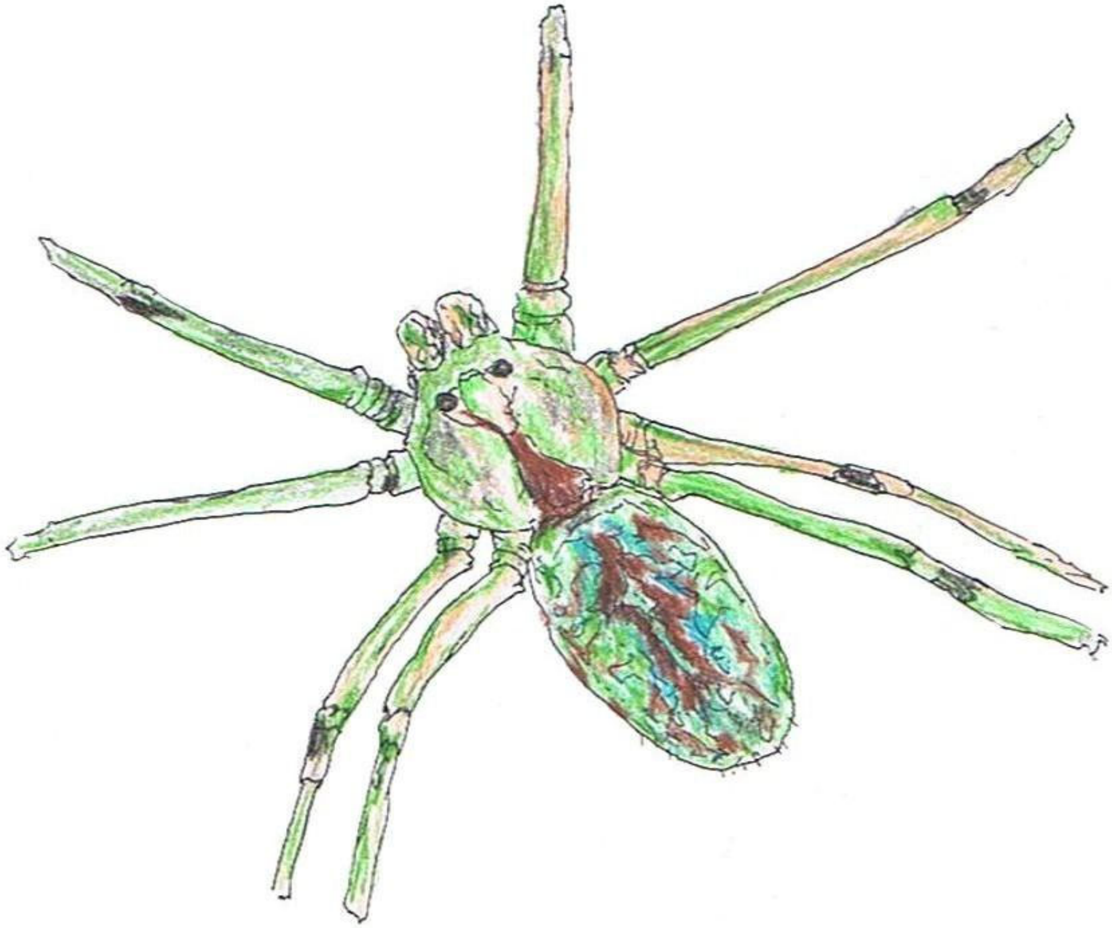
WOODLOUSE HUNTER
(DYSDERA CROCATA)

Woodlouse spider lacks any markings on its body.

The woodlouse spider, Dysdera crocata, has six eyes arranged in two groups of three (triads) and no bodily markings; nonetheless, it is commonly mistaken for a recluse in the United States.

Spiders with Violin-Shaped or Other Dark Markings
Many common tan or gray spiders have dark markings on the head region, which convinces people that they have caught a bona fide recluse spider. These spiders include cellar spiders (Psilochorus spp., Physocyclus spp.), pirate spiders (Mimetus spp.), and sheet web spiders (Linyphiidae). The marbled cellar spider, Holocnemus pluchei, also confuses people even though the dark marks are on the ventral (underside) not the dorsal (top) surface of the body.

Seek medical attention if you think you have a spider bite. If possible, collect up the spider or what remains of it and take with you to your doctor or emergency clinic.



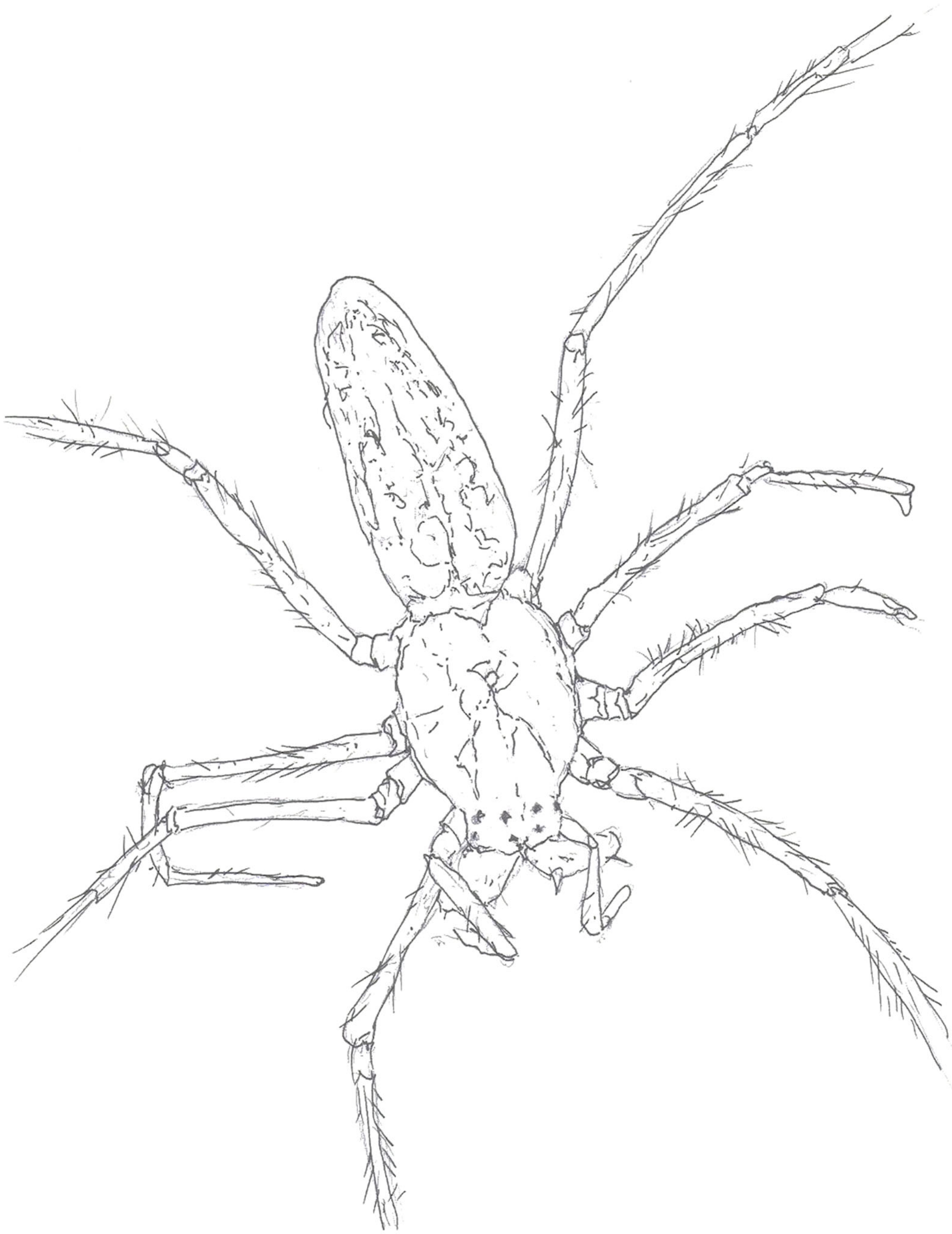
MARBLED CELLAR SPIDER
(HOLOCNEMUS PLUCHEI)

Cellar spiders have a darkened area on their cephalothorax (head region) but have 8 eyes.

Ubiquitous Brown Spiders
Virtually every spider that is tan or brown has been turned in as a potential brown recluse. There are hundreds of species of these spiders. They include ground spiders (Gnaphosidae), sac spiders (Cheiracanthium spp., Trachelas spp., and many of the liocranoid spiders), wolf spiders (Lycosidae), grass spiders (Agelenidae), orb weavers (Araneidae), and male crevice spiders (Filistatidae).

More specifically, males of both the western black widow (Latrodectus hesperus) and the false black widow (Steatoda grossa) are frequently brought in for recluse verification. All of these brown spiders have eight eyes and can quickly be eliminated from consideration.

Seek medical attention if you think you have a spider bite. If possible, collect up the spider or what remains of it and take with you to your doctor or emergency clinic.



LONG- JAWED ORB WEAVER SPECIES

Some of the spiders in this group that can cause a nasty bite include the running spider, jumping spider, wolf spider, tarantula, sac spider, orbweaver spider and the northwestern brown spider, also known as the hobo spider.

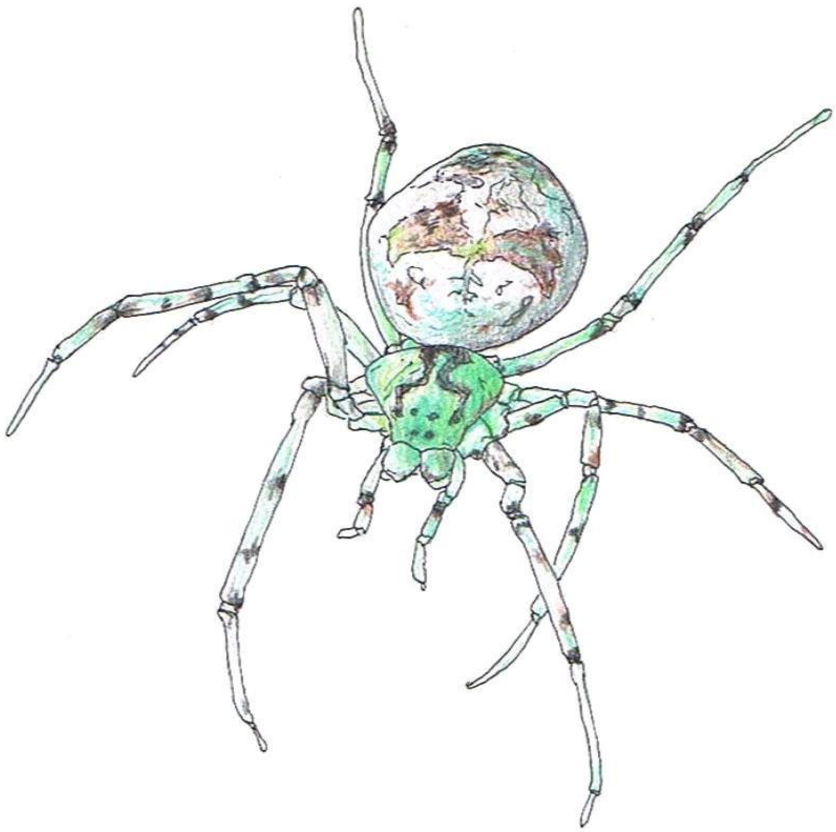
Orb Weavers (Araneidae) – Human Biters- Harmless

AMERICAN HOUSE SPIDER
CROSS-ORBWEAVER
(ARANEUS DIADEMATUS)

Individual spiders' coloring can range from extremely light yellow to very dark grey, but all European garden spiders have mottled markings across the back with five or more large white dots forming a cross.

The white dots result from cells that are filled with guanine, which is a byproduct of protein metabolism. The third pair of legs of garden spiders are specialized for assisting in the spinning of orb webs. These spiders also use them to move around on their web without getting stuck. These legs are useful only in the web; while on the ground, these legs are of little value.

Garden spiders have been known to stridulate when threatened. Since this tends to be a passive animal, it is difficult to provoke to bite- but if it does, the bite is just slightly unpleasant and completely harmless to humans.



ORBWEAVER SPECIES
(METELLINA SEGMENTATA)

Metellina (or Meta) segmentata. Is a colorful stretch spider that builds orb webs, and is often seen in late summer/autumn. The webs are built by the larger females who usually lie head down on the web, as in this photo, waiting for prey to get entangled in the web. The prey is then quickly captured and wrapped in silk before being eaten. Orb Spiders are said to eat their webs each night, along with many of the small insects stuck to it. They have been observed doing this within a couple of minutes. A new web is then spun in the morning. The much smaller male will approach the female cautiously in order to mate. If not careful, he could end up being eaten by her. Seek medical attention if you think you have a spider bite. If possible, collect up the spider or what remains of it and take with you to your doctor or emergency clinic.

Orb Weaving Spiders
Orb weavers (Family Araneidae) comprise a huge family of spiders, of which there are several hundred species in North America. These spiders vary greatly in color, shape and size, measuring between 2 - 30mm (1/16 -- 1 1/4") long. They have eight eyes arranged in two horizontal rows of four eyes each. The males are generally much smaller than the females and commonly lack the showy coloring of their fairer sex. They often spin their own smaller orb web near an outlying portion of the female's, and I've noticed most males give the females wide berth. Indeed, I rarely see male orb weavers, they are so reclusive.

Venom toxicity - the bite of Orb-Weaving Spiders is of low risk (not toxic) to humans. They are a non-aggressive group of spiders. Seldom bite. Be careful not to walk into their webs at night - the fright of this spider crawling over one's face can be terrifying and may cause a heart attack, particularly to the susceptible over 40 year olds.

Spider Identification - an adult is about 2/3 to more than 1 inch in body length - has a bulbous abdomen - often colorful - dark to light brown pattern. The common Golden Orb-Weaver Spider has a purplish bulbous abdomen with fine hairs.

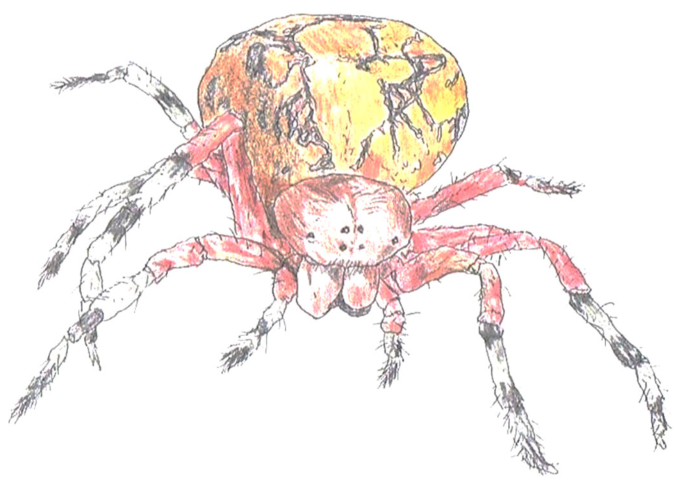
Habitat - often found in summer in garden areas around the home - they spin a large circular web of 6 feet or more, often between buildings and shrubs, to snare flying insects, such as, flies and mosquitoes.

SPINYBACK ORBWEAVER
(GASTERACACANTHA CANCRIFORMIS)

Gasteracantha cancriformis. This is a female orb weaving spider. Like Micrathena gracilis, it also has spines on its abdomen. Some of the spiders in this group that can cause a nasty bite include the running spider, jumping spider, wolf spider, tarantula, sac spider, orbweaver spider and the northwestern brown spider, also known as the hobo spider.

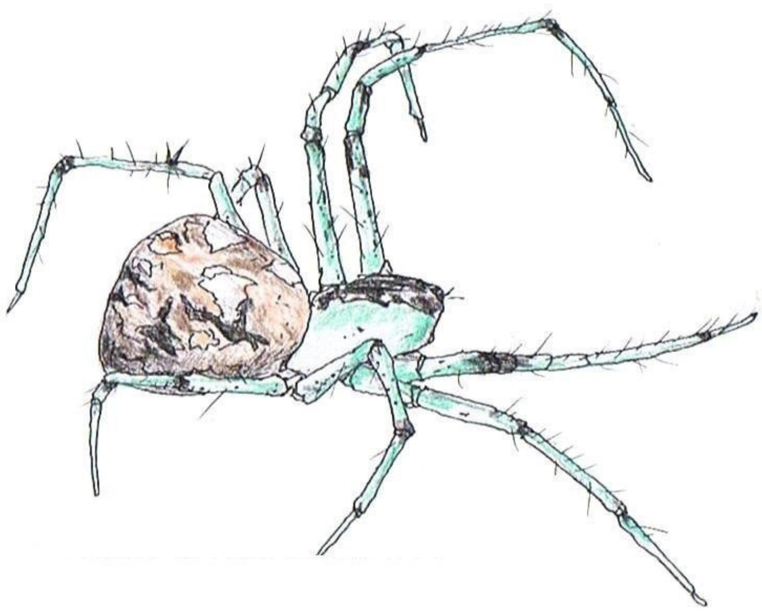
SHAMROCK SPIDER
(ARANEUA TRIFOLIUM)

Aranea trifolium is commonly named the shamrock spider. She is a rather large orb-weaver. She is off-white with dark median longitudinal stripe and with dark marginal stripes. Legs are white to yellow with dark annulations. Abdomen off-white, reddish or purplish, sometimes greenish. Colored specimens usually with paired and unpaired angular white spots. venter dark, usually unmarked.



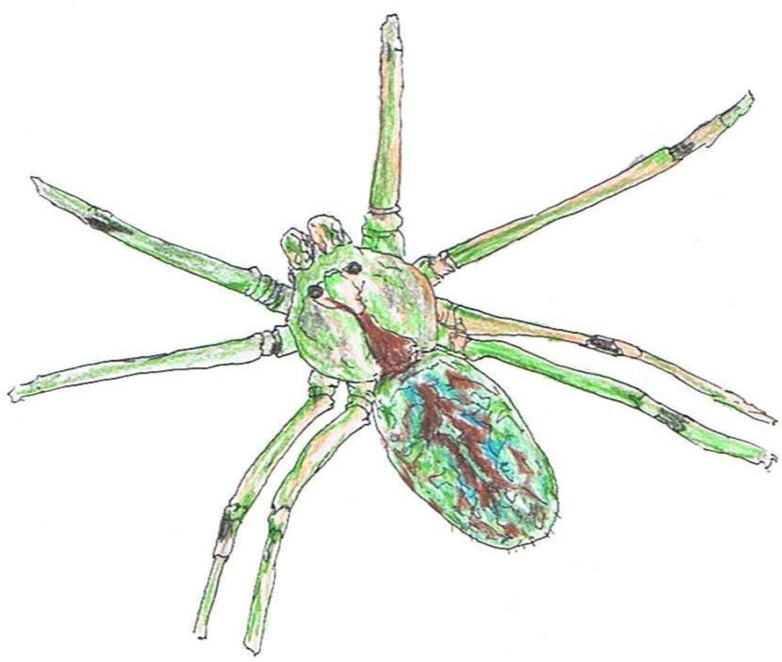
ORANGE GARDEN SPIDER
(ARANEA GIGAS)

Hentzia basilica Those who have seen a spider of this species spin its web indicate that it first produces a horizontal orb having more than 50 radii; then it attaches numerous silk threads to the outer portions of the orb, pulls them downward, and anchors them; finally it connects numerous silk threads to the more central parts of the orb, pulls them upward, and fastens them. The appearance of the final dome-shaped web with the supporting lines led to Basilica Spider as its common name.

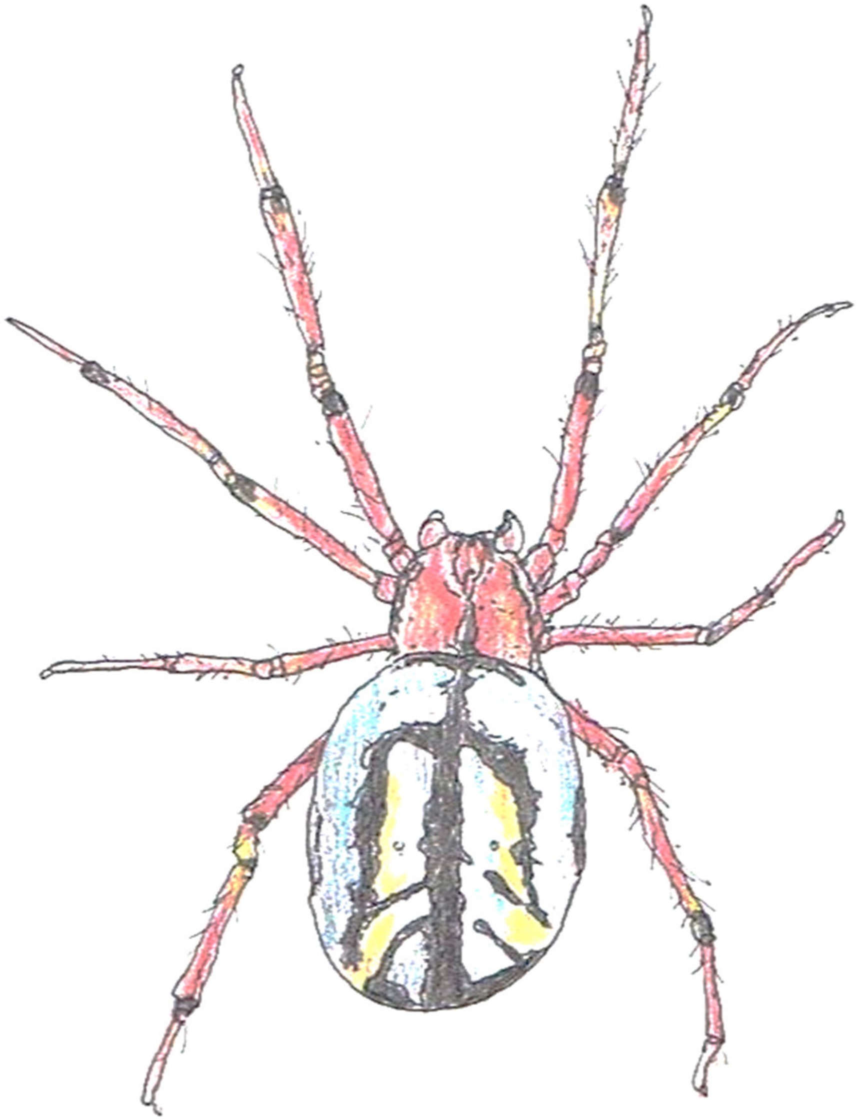


BOWL & DOILY SPIDER
(MIMETUS INTERFECTOR)

Mimetus interfector. It is an unusual spider in that it climbs into the webs of other spiders (usually orb weavers) and preys upon them. Thus, to obtain food, it does not spin a web of its own.



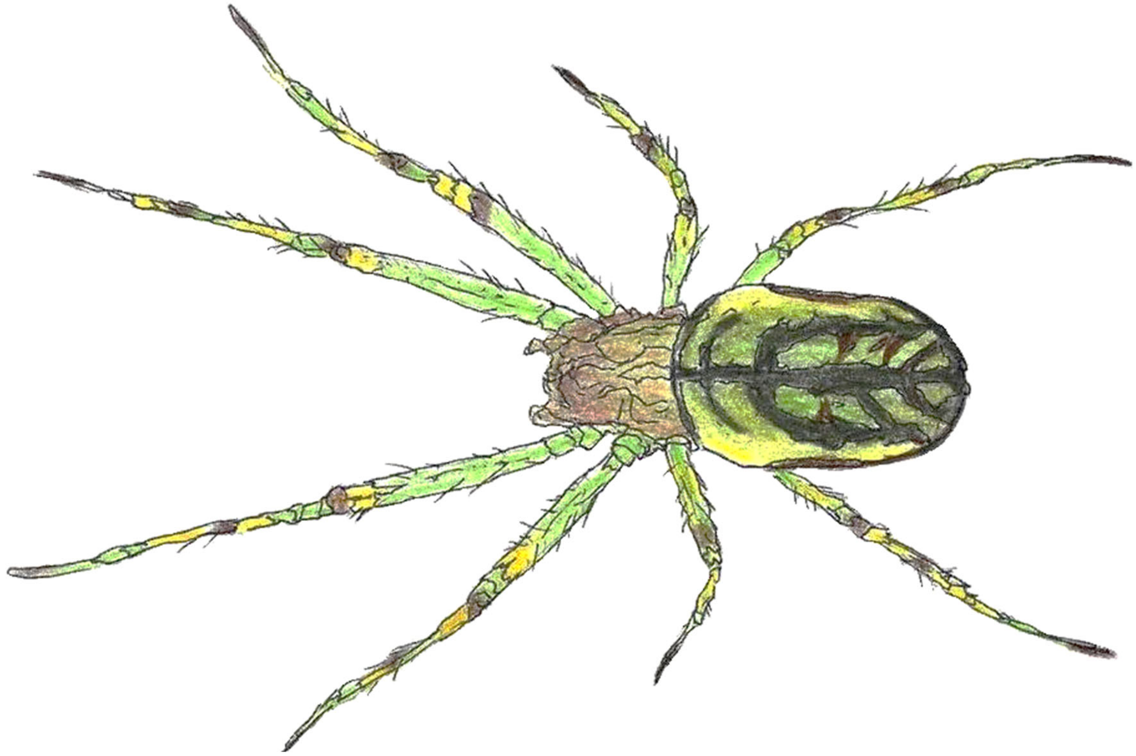
MARBLED CLEEAR SPIDER
(HOLOCNEMUS PLUCHEI)



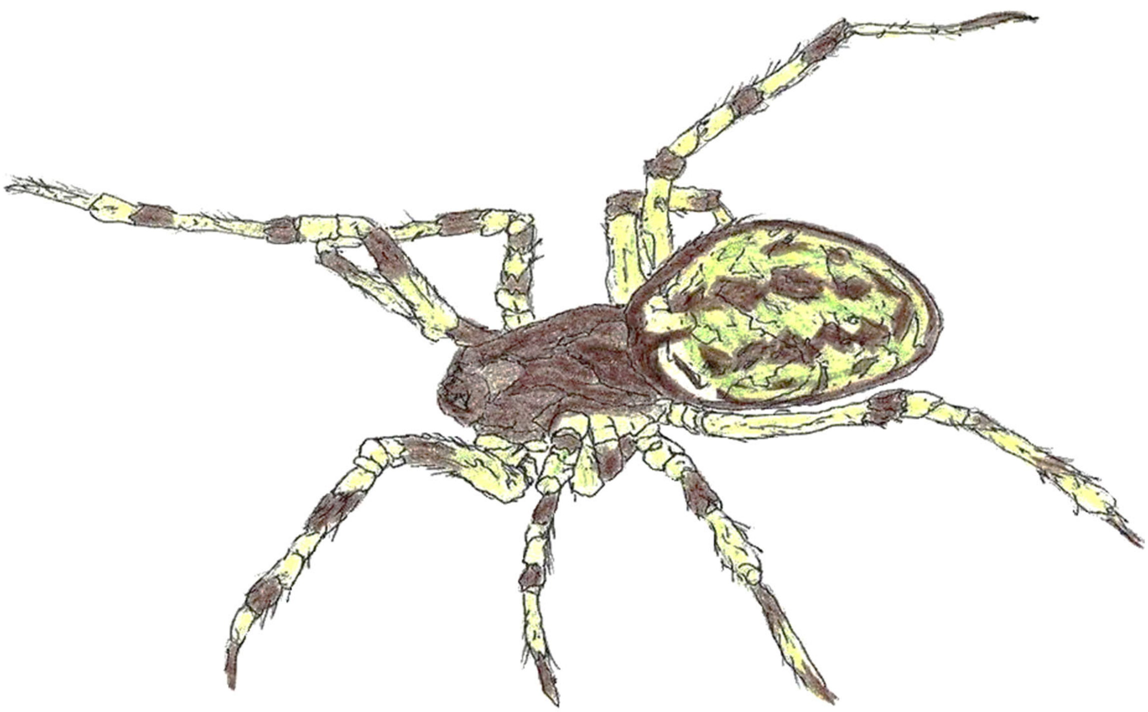
ORCHARD SPIDER
(LEUCAUGE VENUSTA)

The Orchard spider (*Leucauge venusta*) is a long-jawed, orbweaver spider that may be found from the East Coast, reaching into the central US. The web is often oriented horizontally, with the spider hanging down in the center.

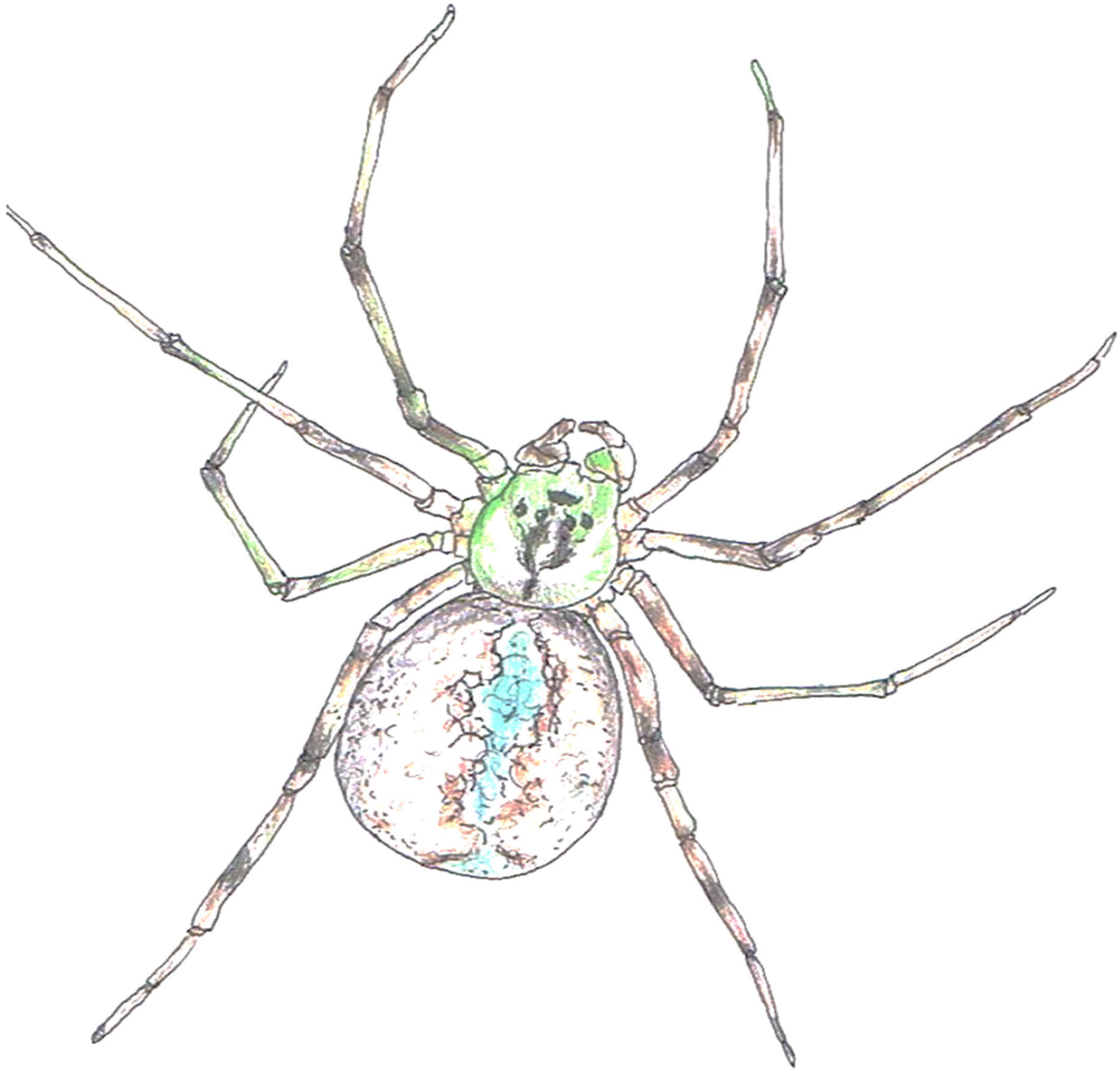
The neon yellow, orange, or red spots on the rear of the abdomen are variable in size among individuals and sometimes absent. This species is parasitized by a wasp larva, which attaches itself externally at the junction of the cephalothorax and abdomen.



ORCHARD SPIDER

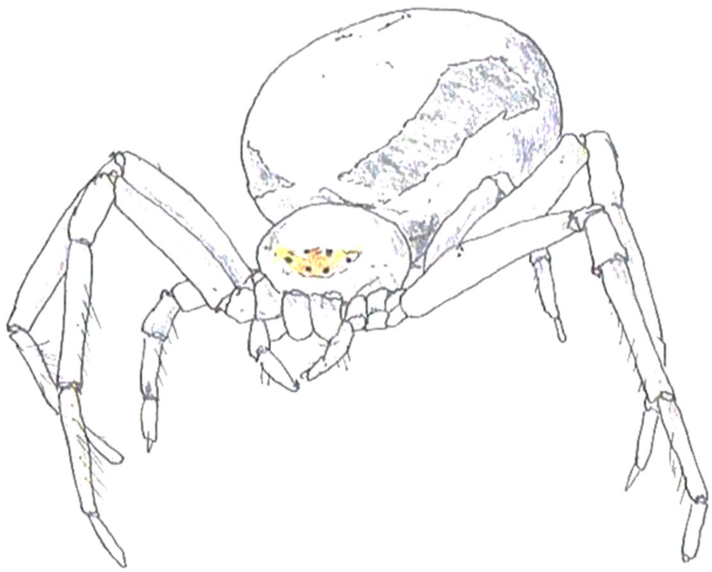


AMERICAN HOUSE SPIDER



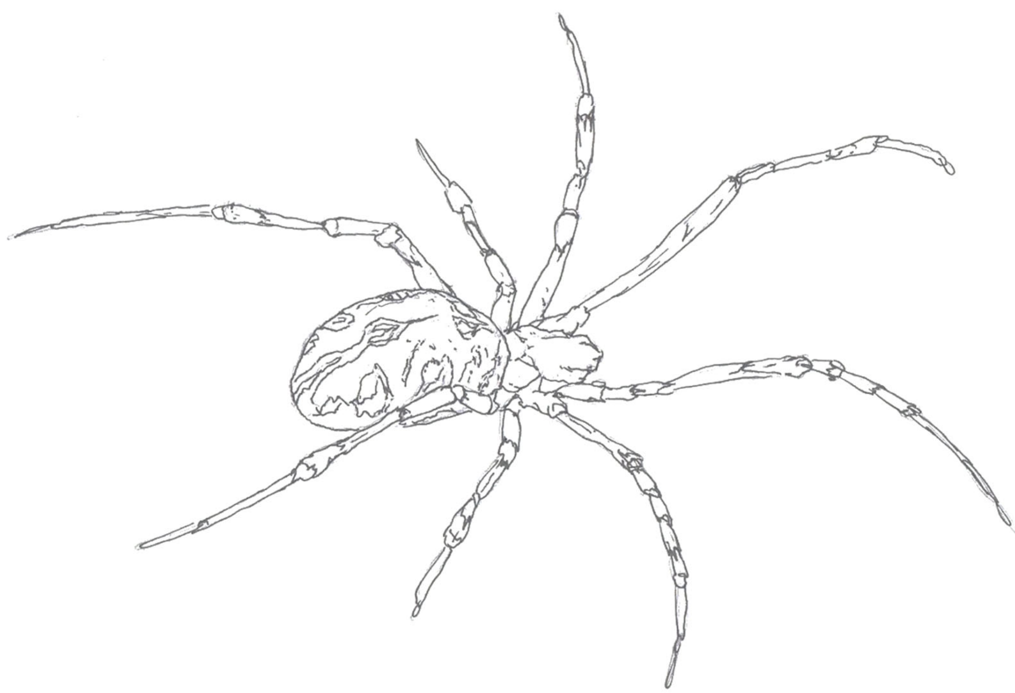
HAMMOCK SPIDER
(LINYPHIA PHRYGIANA)

This is a common group of small spiders (order Araneida), numbering about 2,000 species throughout the world. Most are less than 6 mm ($^{1}/_{4}$ inch) in length and are seldom seen. Their webs are flat and sheet like and dome- or cup-shaped. The spider is usually found on the lower side of the web and often between two layers of webbing. The hammock spider (*Linyphia phrygiana*), native to North America, builds a hammock-shaped web.

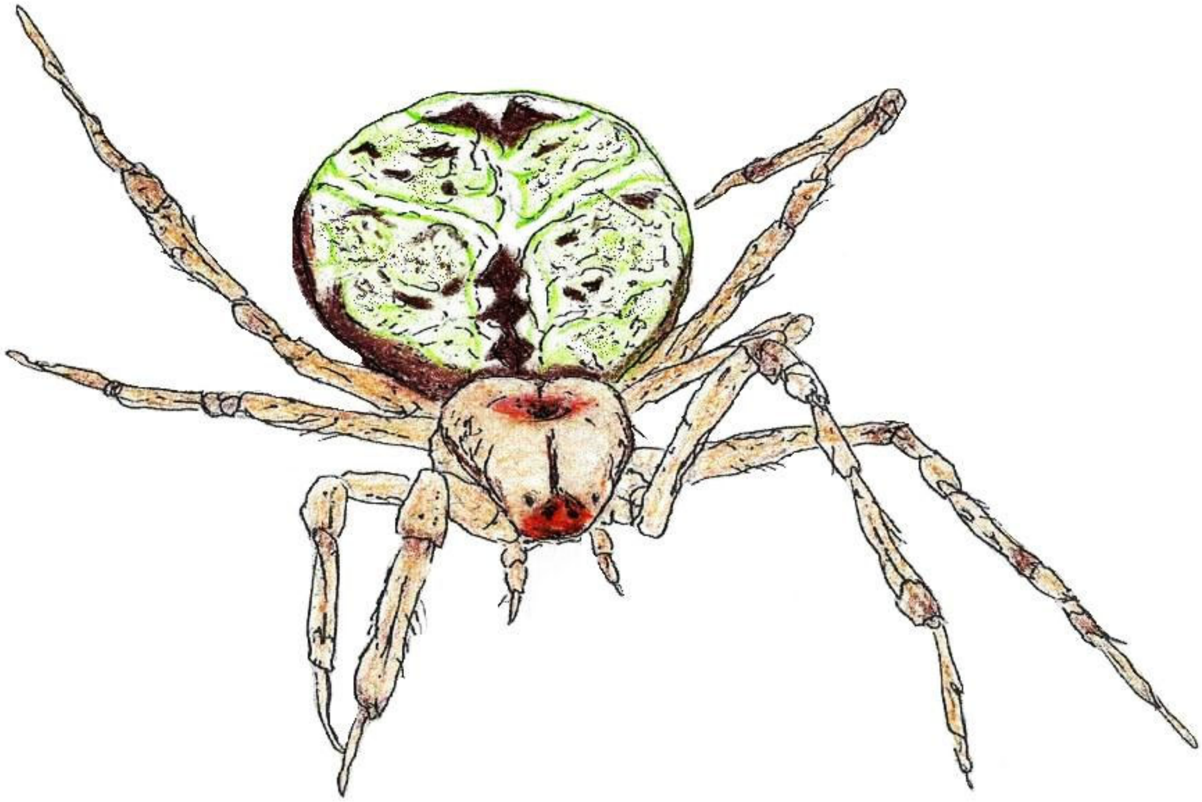


**CRAB SPIDER
(MISUMENA VATIA)**

Misumena vatia is one of the crab spiders. Crab spiders are masters of disguise, and some, such as this one, they can gradually change their color to that of the flower in which they hide to ambush unobservant insects.

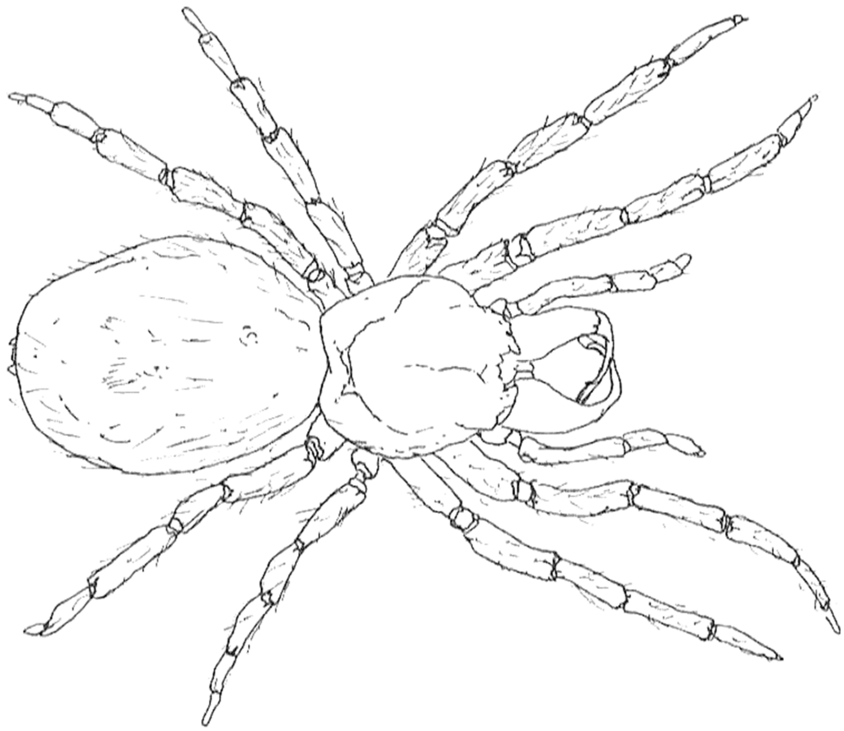


BROWN WIDOW SPIDER



THERIDION FORDUM

Parson Spiders – Human Biter- Mostly Harmless

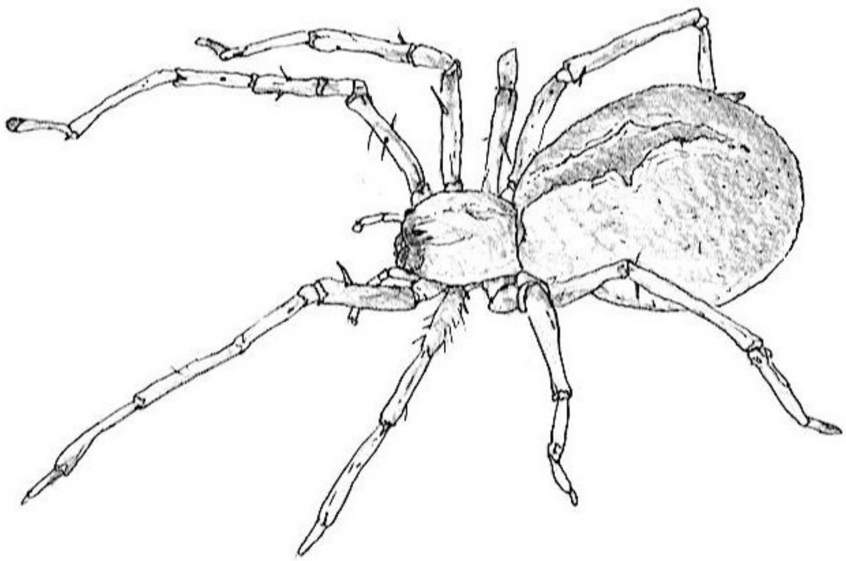


PARSON SPIDER
(HEPYLLUS ECCLESIASTICUS)

The parson spider is a nuisance in homes and is generally nontoxic; although some people may experience allergic reactions to the bites. The parson spider is about 1/2 inch long and may vary in color from brown to black. The front segment of the body tends to be a chestnut color, while the abdomen is grayish, with a distinctive white or pink pattern along its middle. The body is covered with fine hairs, giving a velvety appearance. The parson spider is usually found outdoors under rocks or in piles of brush or firewood. This spider does not spin a web, but wanders on the ground in search of prey.

Indoors, this spider wanders about at night and conceals itself beneath objects or in clothing during the day. Most bites from this spider occur at night or when it is trapped in clothing. While the parson spider is not considered poisonous, bite symptoms vary in severity.

Some people may experience localized allergic swelling and itching, in addition to initial pain. A few persons may experience excessive swelling, nervousness, nausea, sweating, and elevated temperatures from the bites.



SAC SPIDER
(CHEIRACONTHIUM MILDEI)

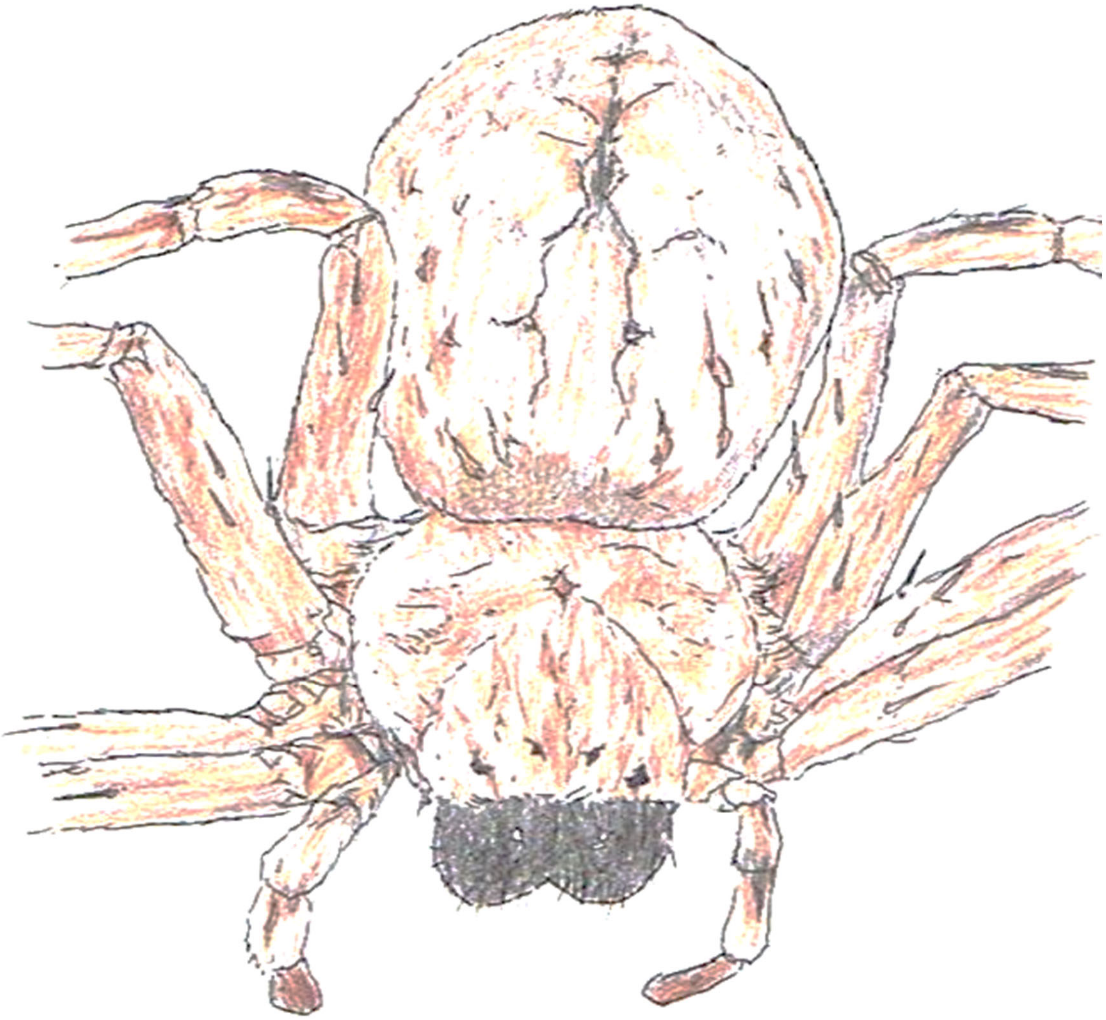
Sac Spiders

Some members of this group of spiders are quite common in homes. These spiders are light or dark-colored and have a darker coloration on the cephalic (head) region. The body is covered with short hairs, which give it a silky appearance.

The nighttime feeding behavior of sac spiders is similar to that of the parson spider. These spiders do not capture prey in webs, but actively hunt their prey at night. During the day, they hide in tubular silken capsules that they construct, which gives them their common name. You may be able to find silken capsules on walls, ceiling, draperies, and other locations. Bites from these spiders may result in localized allergic reactions in some individuals.

Crab Spiders

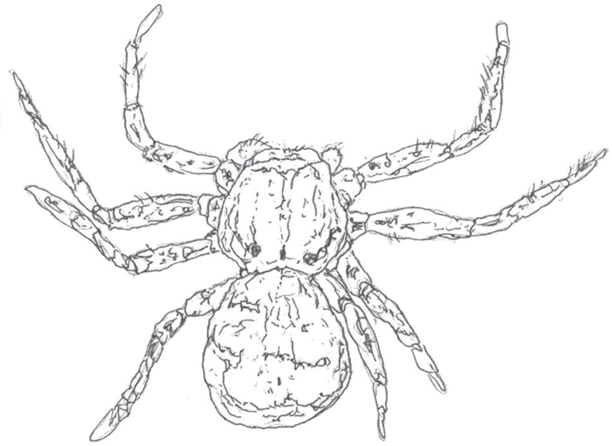
CRAB SPIDERS



GIANT CRAB SPIDER
(OILIOS GIGANTEUS)

Crab Spider
Small crab spiders are dark or tan; some are lightly colored orange, yellow or creamy white. Their legs extend out from their sides causing them to scuttle back and forth in a crab-like fashion. These spiders hide in flower blossoms and may be brought inside in cut flowers.

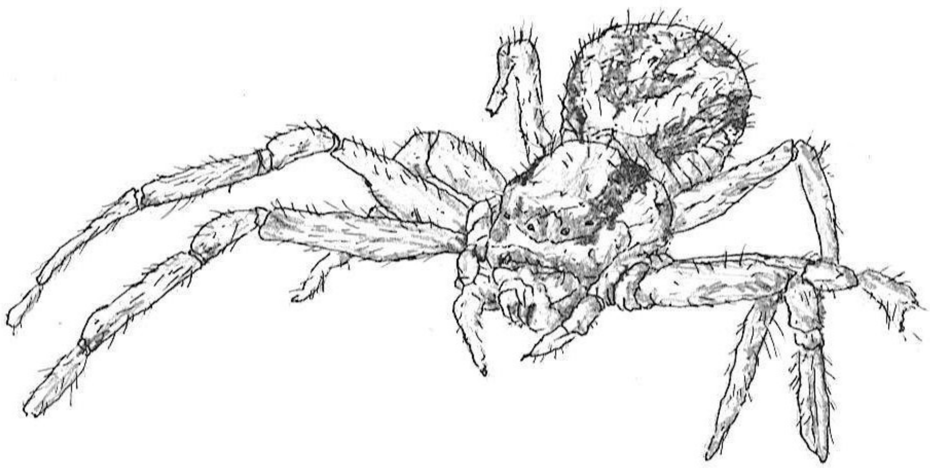
These spiders catch prey in open flowers. They catch insects, such as bees, flies, and butterflies, which come to the flower for nectar. Crab spiders are capable of camouflage changing color to match the color of the flower. They can change to white, yellow, or pink within several days. One of the best ways to find crab spiders is by looking in flowers for insects that seem to be at an odd angle these are insects that are being eaten! Crab spiders are distinguished by their sideways, crab-like walk.



XYSTICUS LUCTANS **XYSTICUS FEROX**

Xysticus luctans (left) and ***Xysticus ferox*** (right) (Comstock, pp. 549-551) are small crab spiders. The crab-like reach of its legs is useful for grabbing its prey and holding on until its venom has its effect. The bees and other insects that crab spiders attack in flowers are generally quite a bit larger than the crab spider itself. Thus, crab spiders can easily lose part of a foreleg even when their victim is overcome. Given time, they have the ability to regrow missing parts of limbs.

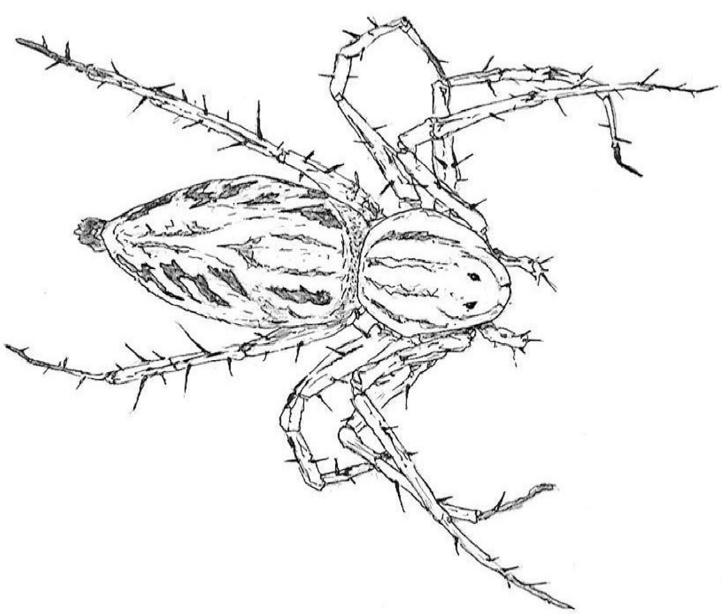
CRAB SPIDER SPECIES



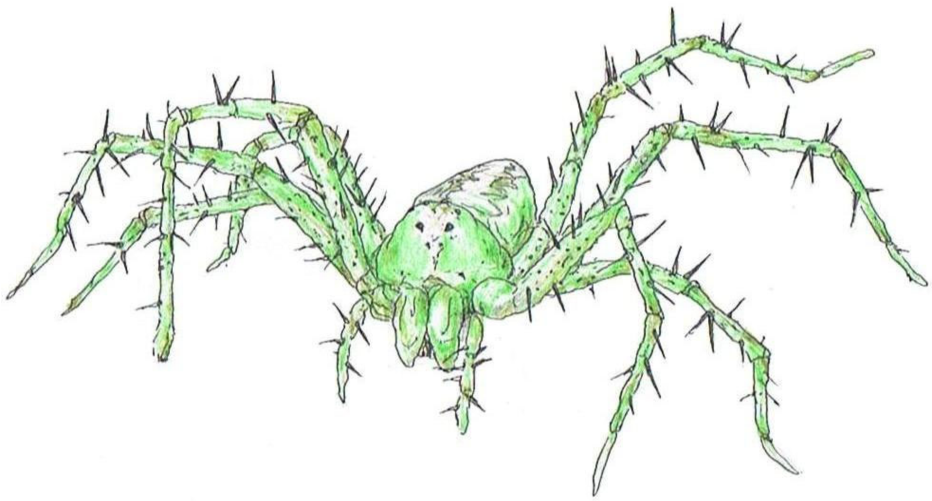
CRAB SPIDER ***(Misumenops Asperatus)***

One of the “flower spiders” (so-called because they generally hunt in similarly colored flowers for visitors such as bees and flies, and they are very happy), ***Misumenops asperatus*** is a much smaller relative of the better-known goldenrod spider *Misumena vatia*.

M. asperatus is easily told by the markings on its abdomen (a "capped" V, with the point of the V at the end of the somewhat angular abdomen) and its striped legs. The background colors of the abdomen is often whitish or even a pale greenish color, in contrast to its larger relatives, which may be white, but are more often yellow.



LYNX SPIDER
(OXYOPES SALTICUS)



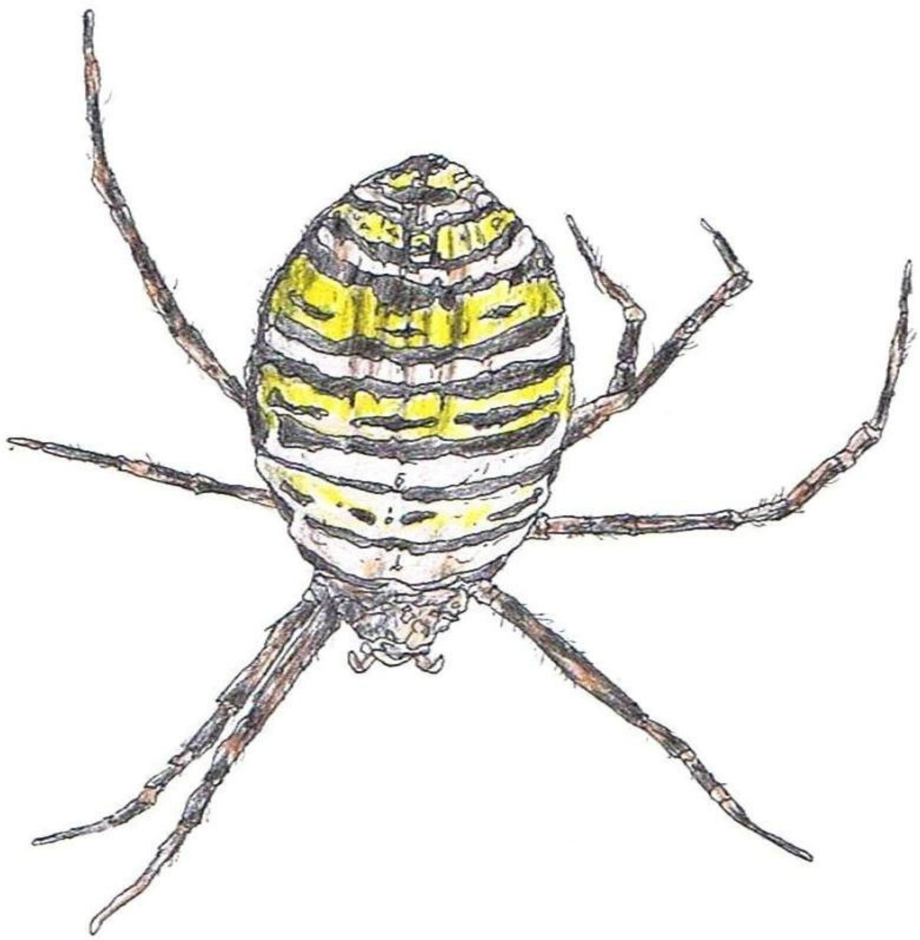
GREEN LYNX SPIDER
(PEUCETIA VIRIDANS)

Peucetia viridans is one of the Lynx spiders. They catch their prey in several ways. They can run rapidly about plants and jump from branch to nearby branch and they can wait in ambush (like a wildcat) and drop down on their prey. This species has an interesting eye arrangement with two small eyes in front, then two larger eyes behind them, and a row of four eyes behind them. This is a large spider, and it has excellent vision as well as depth perception.

MICRATHENA GRACILIS

Micrathena gracilis Unlike various insects where numerous similar species can occur, there appear to be relatively few species of spiders that give similar difficulty. However, the names of more than a few spiders have led to controversy among experts. While Professor Comstock's book lacks some of the latest professionally approved scientific names, its descriptions are accurate and very useful (Reference: Professor Comstock's "*The Spider Book*").

Miranda aurantia (Comstock, pp. 448-452) has been given the common names: the "Orange Garden Spider," the "Black and Yellow Garden Spider," “Zig Zag Spider,” and the "Writing Spider". The female shown above is a large orb-weaving spider. Its web is frequently found constructed close to the ground in grassy fields in late summer and early autumn when grasshoppers are abundant. From the time a grasshopper lands in its web, it takes the spider just a few seconds to wrap the grasshopper in a shroud of silk and store it for later consumption. To illustrate how different names have been used, B. J. Kaston in "*The Spiders*," (William Brown Col. Publishers, Dubuque, Iowa, Second Edition, 1972) refers on page 172 to this spider as Argiope aurantia. Photo from Rusty Randall.

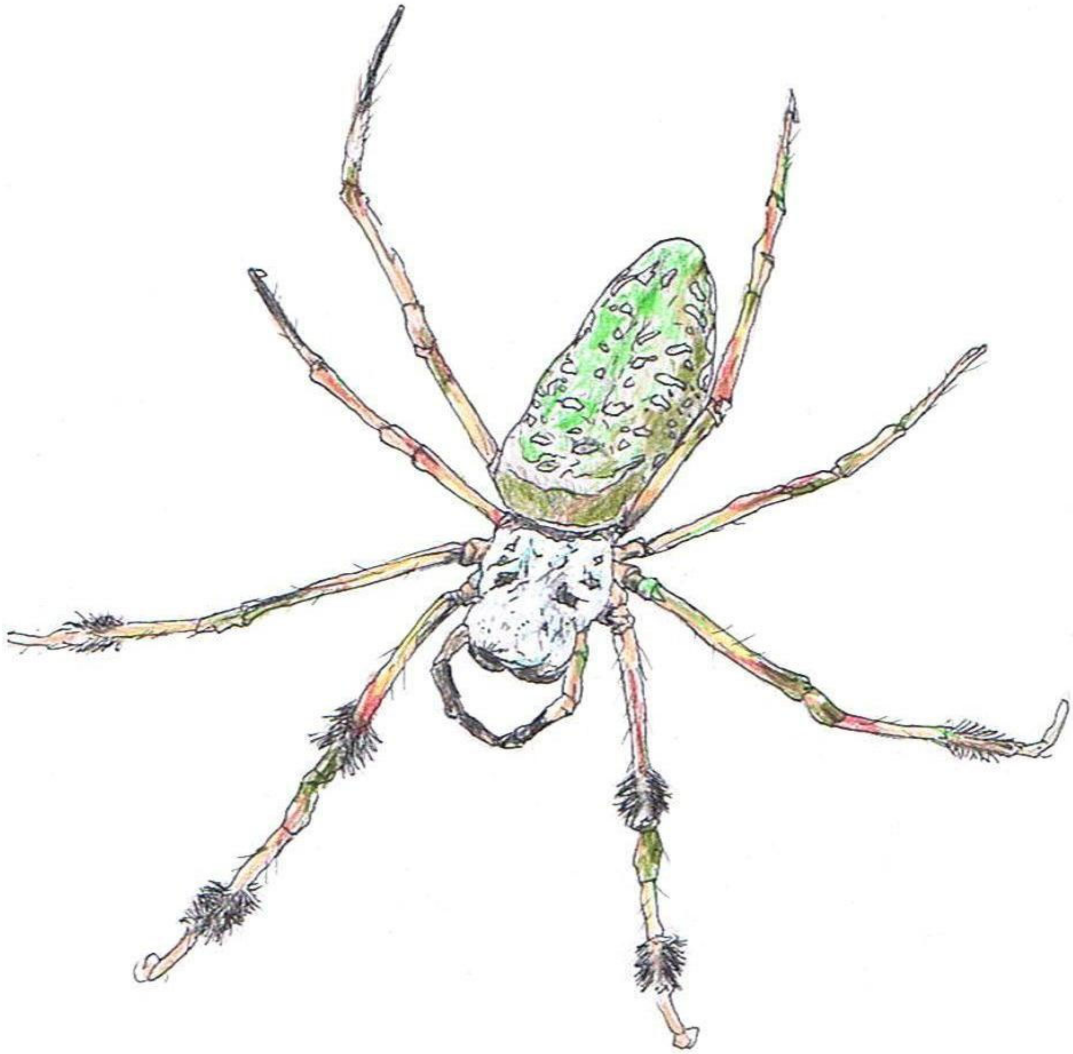


BANDED GARDEN SPIDER
(ARGIOPE TRIFASCIATA)

Argiope aurantia and ***Argiope trifasciata*** are common spiders throughout most of the US. They can often be found building webs side by side, but *A. trifasciata* tends to favor slightly drier habitats. *A. trifasciata* lacks the strong black patches of *A. aurantia*, although it often has thin black bands on its abdomen.

While *A. aurantia* includes a stabilimentum in almost every single web it builds, *A. trifasciata* only sometimes builds a stabilimentum. Silk stabilimenta can be a good defense against predators but also cost spiders prey so they have to decide carefully whether or not to include a stabilimentum in each web. *Argiope* uses its past foraging success to help make this decision. Hungry spiders, which most need to capture prey, are less likely to build stabilimenta.

Metargiope trifasciata is also known as the Banded Garden Spider.

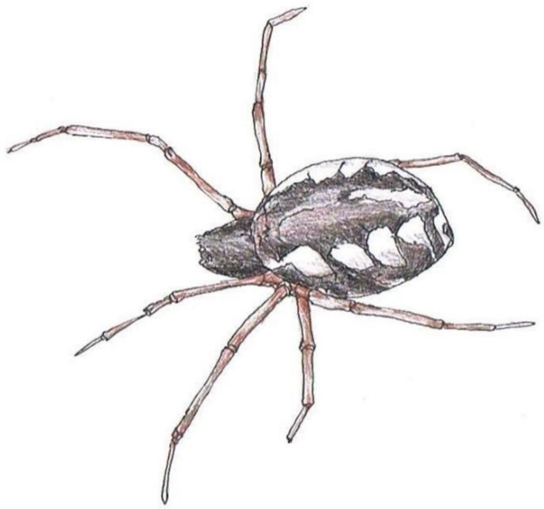


GOLDEN SILK SPIDER
(NEPHILA CLAVIPES)

Nephila clavipes Is a very large orb-weaving southern spider whose web is unusually strong. Small birds can even become fatally trapped. Because the lowest part of its web is usually at least 7 feet above the ground, with long support threads between tall shrubs or trees, it creates an interesting silhouette against a blue sky, particularly when the sun is low in the sky. It has remarkable tufts of hair in patches on its legs.

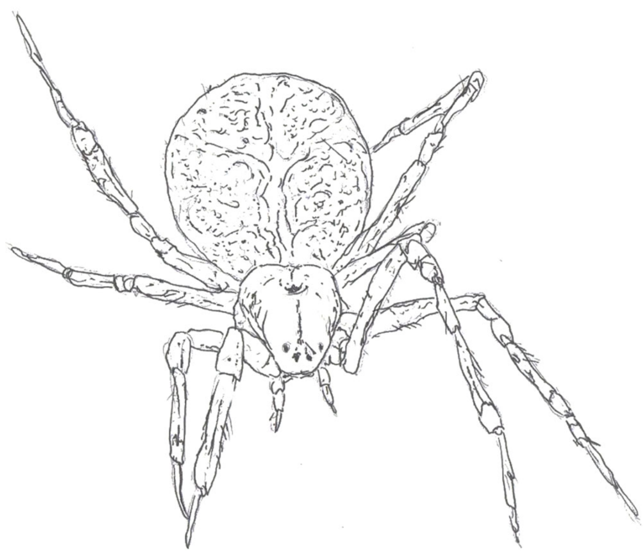
When its strong web is freshly made, has the unusual character that the spiral strands make angles with the radial strands that are closer to right angles than is the case with other orb-weavers.

Tetragnatha elongata (Comstock, pp. 425-426) Has its chelacerae conspicuously extend forward. Its two fangs are at the ends of the two chelacerae. This is an orb-weaving spider that, unlike the orb weavers of most other genera, spins its web in a plane that is tilted about 45 degrees from the vertical and usually positions it near or over a body of water, such as a creek or lake.



BOWL & DOILY SPIDER
(LINYPHIA COMMUNIS)

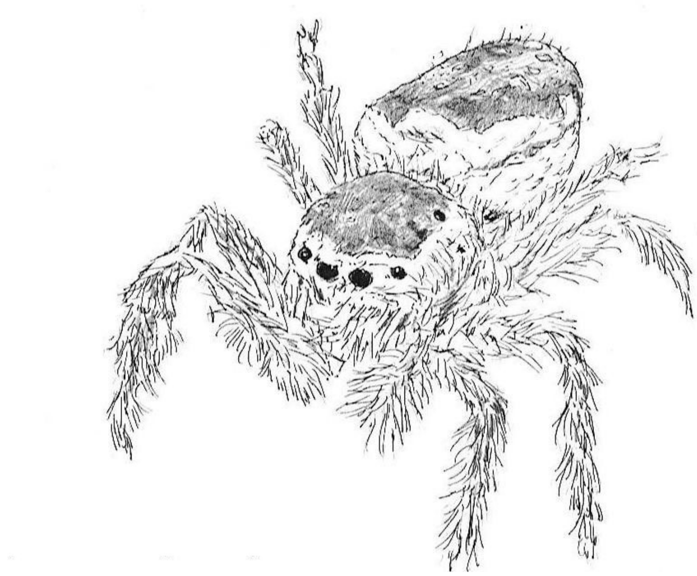
Linyphia communis the spider's common name of bowl-and-doily spider. When waiting for a prey, it resides on the bowl-like upper portion. Captured insects are usually ones that have flown between the bowl and doily parts of the web and become trapped therein, or on the top of the doily. From the spider's position on the bowl, it walks on the bowl until it is above the trapped insect and then approaches the insect directly.



THERIDION FORDUM

Theridion fordum (Comstock, pp. 361-362) It is a near (but much larger) relative of the common house spider (Theridion tepadariorum) and has a similar helter-skelter type of web. Its web is certainly not confined to one plane, as in the case of orb-weavers, and it does not have a simple geometric outline as, for example, the two parts to the web of the bowl-and-doily spider.

Jumping Spiders – Human Biters

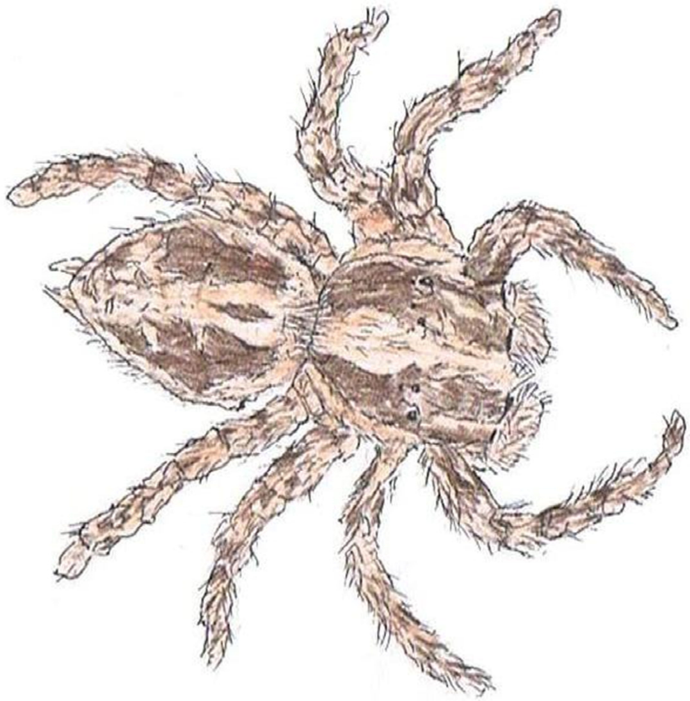


JUMPING SPIDER
(THIODINA SYLVANA

Jumping spiders appear to operate in a stealth mode, moving and turning slowly to face objects of interest in their surroundings. This genus of spiders is known for their scanning telescopic anterior medial eyes, and both extension and retraction of the articulated foot pads. A God-designed hunting machine that will hunt other spiders.

Phidippus audax (Comstock, pp. 689-690) is a type of jumping spider. Unlike spiders that spin a web to catch their prey, the vision of jumping spiders (and wolf spiders) is excellent. Jumping spiders like to turn and look directly at the person who is taking their photograph.

You may have noticed the greatest variety of jumping spiders at golf courses in the autumn of years having drought conditions, where such spiders can be observed on golf-ball washers waiting for an insect to land for moisture. Then the jump is short and precise. By attaching a silk line to the washer, they can jump, catch their prey, swing around on the line with their prey in their fangs, and climb right up the short silk line to their starting point on the washer.



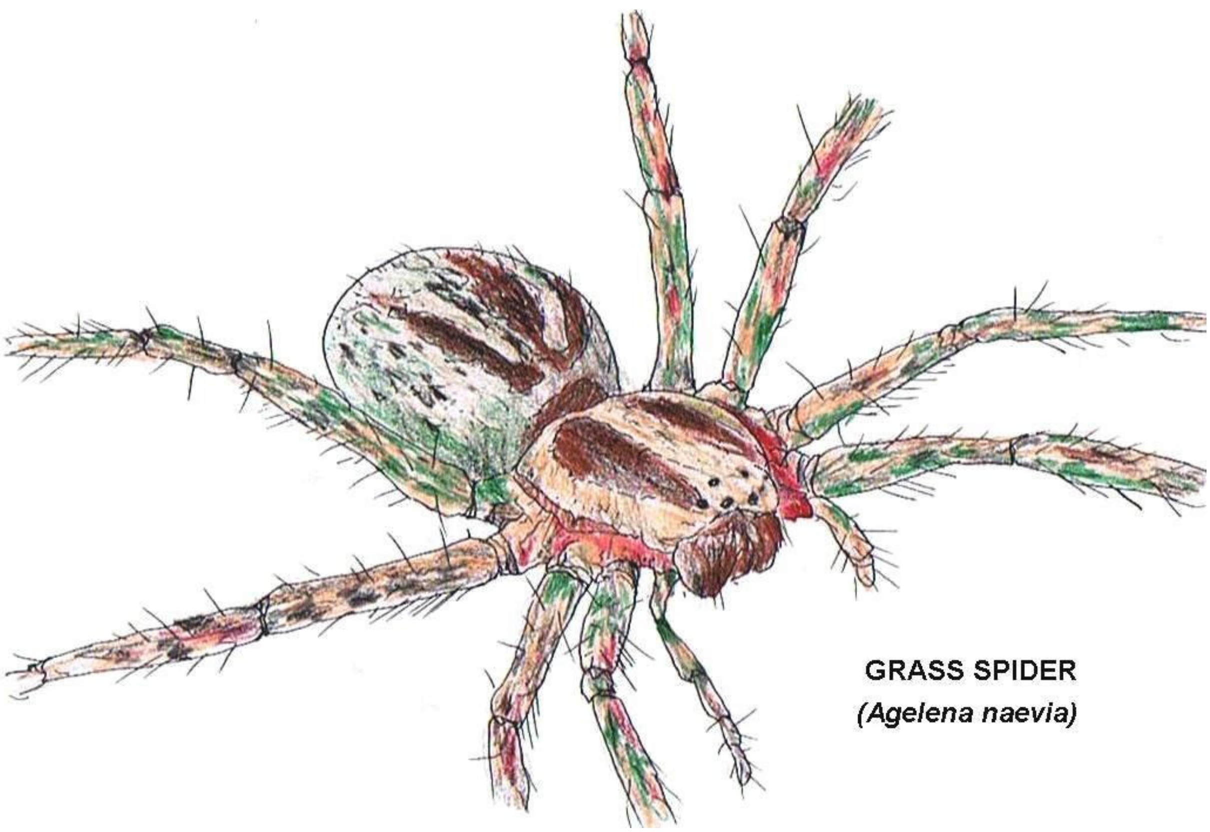
PANTROPICAL JUMPING SPIDER
(PLEXIPPUS PAYKULLI)

Plexippus paykulli The four largest of the eight simple eyes are clearly visible. The other four are much smaller ones behind them and are not noticeable here.

Spiders have eight legs, two chelicerae (the first two appendages of the head, here iridescent greenish-blue) having retracted fangs at their extremities, and two pedipalps, which are short appendages attached to the head on each side of chelicerae. Here, the tips of the pedipalps are enlarged. This distinguishes male spiders from female spiders of all species. Usually, a mature female spider is from somewhat to considerably larger than a mature male spider of the same species. In the case of jumping spiders, the size difference is less accentuated.

Grass Spiders

GRASS SPIDER
LOOKS LIKE WOLF SPIDER



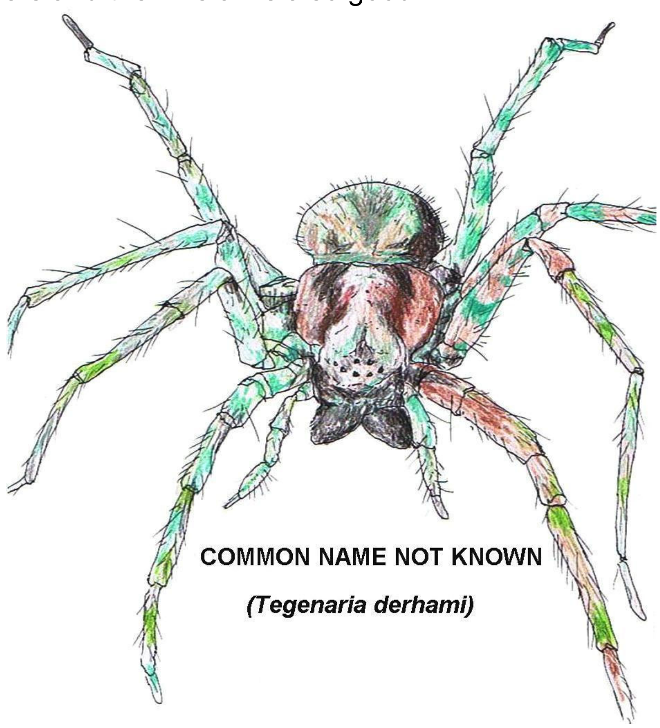
Grass spiders have scientific name Agelenidae, which means saccadic running. Other siblings, in general, move straightly and constantly. These arthropods are also known as funnel weaver spiders. They are dark-yellowish with prolonged cephalothorax and banded limbs. Their front legs are usually longer than hind ones. Male species are at a maximum of 2 cm in size. As for females, they are 1 cm longer. The most distinctive feature is that grass spiders have dark stripes on their back, which stretch from a rear part to its front. Babies don't possess such a trait. Adult species are often mistaken for wolf spiders.

Agelena naevia is commonly called the grass spider. It constructs a web over which it can run quite rapidly. When waiting for prey, it resides hidden in the funnel portion at the upper left of center. When it detects that some part of its web has undergone at least a small relative motion, it emerges rapidly from the inner portion of the funnel and, guided by web vibrations, runs rapidly to the area of disturbance before its visual reflexes dictate what it should then do.

For example, a gentle touch of the web with the tip of a pencil will bring the spider out of its funnel over to the pencil tip in a fraction of a second, before the spider quickly retreats to its hiding place.

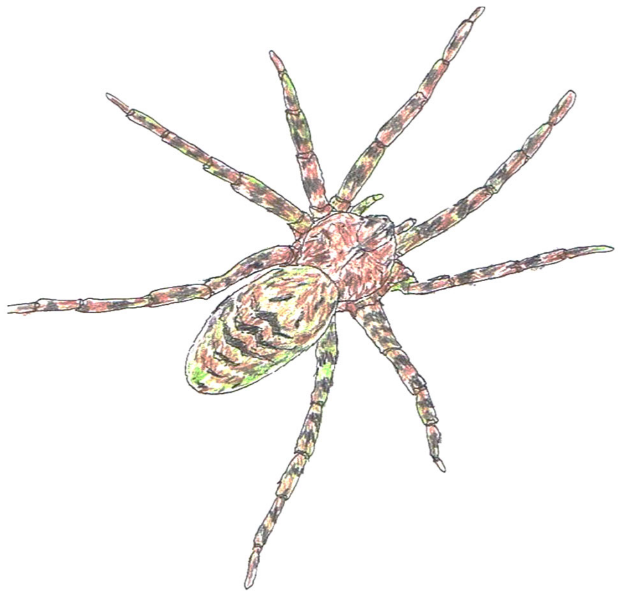
Because the web is reasonably horizontal and without gaps, the spider can run rapidly without concern for the particular strands on which it places its feet. Of course, the eye arrangement of spiders corresponds to their hunting styles.

Grass spiders have their eight simple eyes of approximately the same size arranged in two rows of four each. Jumping spiders have excellent vision; for them depth perception is important. Wolf spiders, photographs of which will be encountered later, run over the ground the way grass spiders run over their web. The eye arrangement of wolf spiders is somewhat like that of grass spiders and their vision is also good.

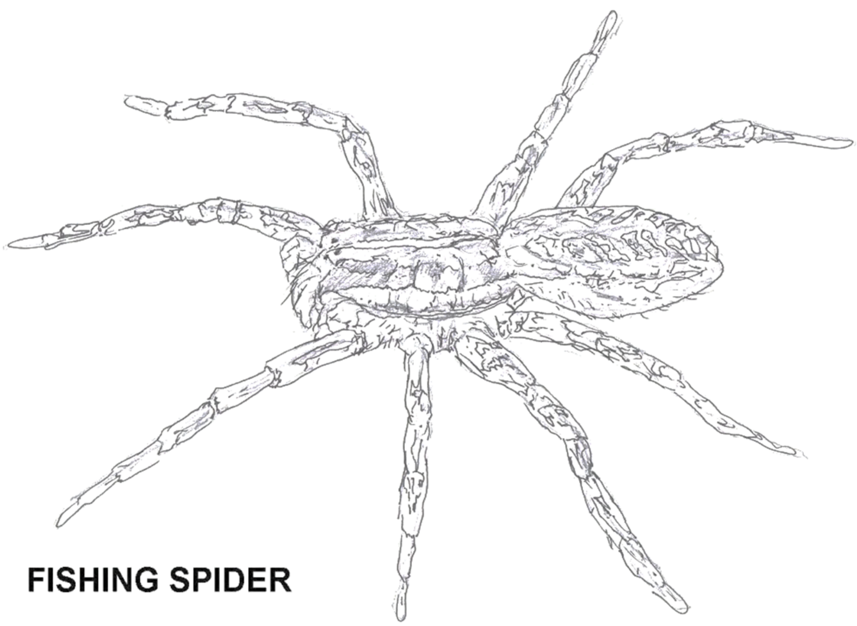


Tegenaria derhami. This spider spins a web somewhat like that of a grass spider and employs similar tactics.

Fishing Spiders – Human Biter



FISHING SPIDER
(DOLOMEDES TENEBROSUS



FISHING SPIDER

One of the so-called fishing spiders. They have the ability to run rapidly on the surface of the water in undisturbed pools of creeks and ponds. The nature of their feet and the surface tension of the water make this possible. Their eight simple eyes are clearly arranged in two curved rows, with the eyes in the second row somewhat larger. Their vision is excellent and of a far-sighted character. For that reason, their hunting style on water is like that of wolf spider on a smooth forest floor.

FISHING SPIDER

D. tenebrosus is a fairly large spider. The females are 15 to 26 millimeters in length; males are 7 to 13 millimeters. Both sexes are brownish gray in color with black and lighter brown markings. The legs of both male and female are banded with alternating brown/black, scalloped annulations on the femora and reddish-brown/black annulations on the tibia. A closely related species, D. scriptus, is similar but has white “W" markings on the posterior portion of the abdomen.

Dolomedes tenebrosus is frequently found far away from water, usually in wooded settings. They hibernate as immature adults (penultimate instar) under stones or loose bark, in tree cavities, and in human-made structures and mature in the spring.

Mature individuals may be found from early May through September. The egg sacs are deposited in June and are carried around by the females until the spiderlings are ready to hatch. Young spiderlings may be found from July through September. The young are guarded by the female in a nursery web and may number 1,000 or more.

Fishing spiders are quite shy and generally run from humans at the slightest movement. Bites are typically no more severe than a bee or wasp sting. Exceptions do occur in individuals who are sensitive to spider venoms.

Pirate Spiders

PIRATE SPIDER – SPIDER EATER
(GENUS MINETUS)

The family Mimetidae are commonly called pirate spiders. Which typically feed on other spiders. The family Mimetidae contains roughly 200 species divided among 12 genera, of which *Mimetus* and *Ero* are the most common. Mimetids are usually yellow and brown and are usually 3 to 7 mm long.

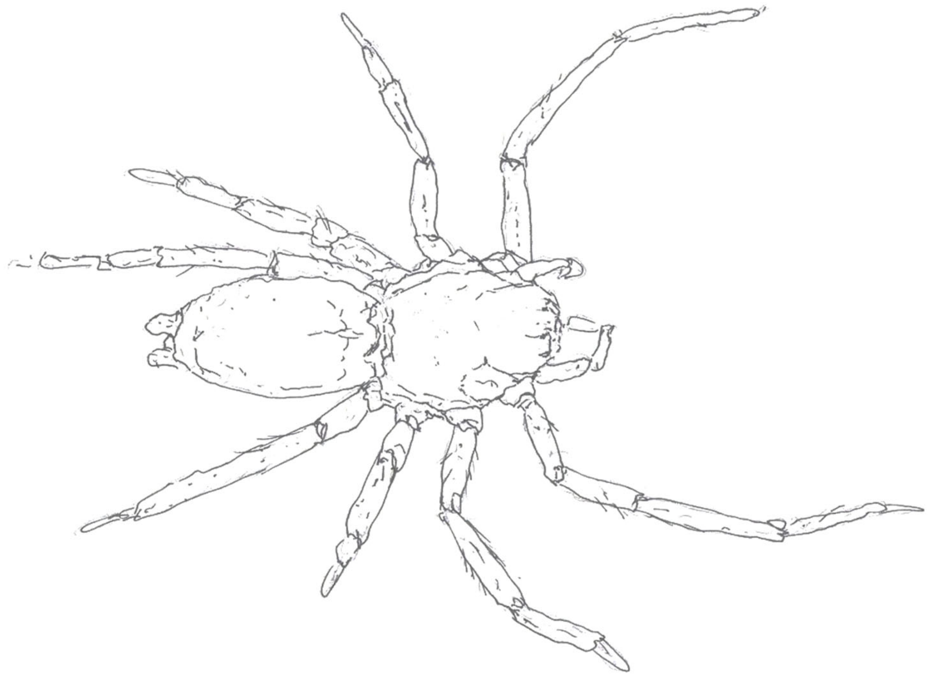
Mimetids can be recognized by the rows of spine-like hairs on their long front legs; the rows consist of a long spine, followed by a series of progressively shorter ones.

Mimetidae usually hunt other spiders by picking at the strands on their prey's web to simulate the movements of either a trapped insect or a potential mate. When their prey comes to investigate, they are instead captured and eaten.

Some mimetids have been observed to feed on insects as well. The spider-feeding habit presents problems in mating, and little is known about how the males court females to avoid being eaten.

PIRATE SPIDERS – SPIDER HUNTERS & EATERS

Sac Spiders – Human Biter
Often confused with Brown Recluse



SAC SPIDER

Sac spider, (family Clubionidae), also called two-clawed hunting spider, any member of a relatively common, widespread family of spiders (order Araneida) that range in body length from 3 to 15 mm (about 0.12 to 0.6 inch) and build silken tubes under stones, in leaves, or in grass.

BROAD FACED SAC SPIDER

The **Yellow Sac Spider** (Cheiracanthium inclusum) is also known as the **Black-Footed Spider**. The Yellow Sac Spider is one of a group of spiders in North America whose bites are generally considered to be medically significant.

The Yellow Sac Spider is very common in most of the United States and is the cause of a lot of spider bites and other unwanted encounters. Yellow Sac Spiders are light yellow to pale yellowish green, sometimes with an orange-brown stripe on top of the abdomen. The cephalothorax (fused head and thorax) of the Yellow Sac Spider is orange brown to reddish and the abdomen is pale yellow to light grey. An adult female sac spider's body is typically 1/4 to 3/8 inches long and its leg span is up to 1 inch.

Males are more slender, with a slightly larger leg span. The first pair of legs is longer than the fourth. Yellow Sac Spiders have eight similarly-sized dark eyes arranged in two horizontal rows.

Some of the spiders in this group that can cause a nasty bite include the running spider, jumping spider, wolf spider, tarantula, sac spider, orbweaver spider and the northwestern brown spider, also known as the hobo spider.

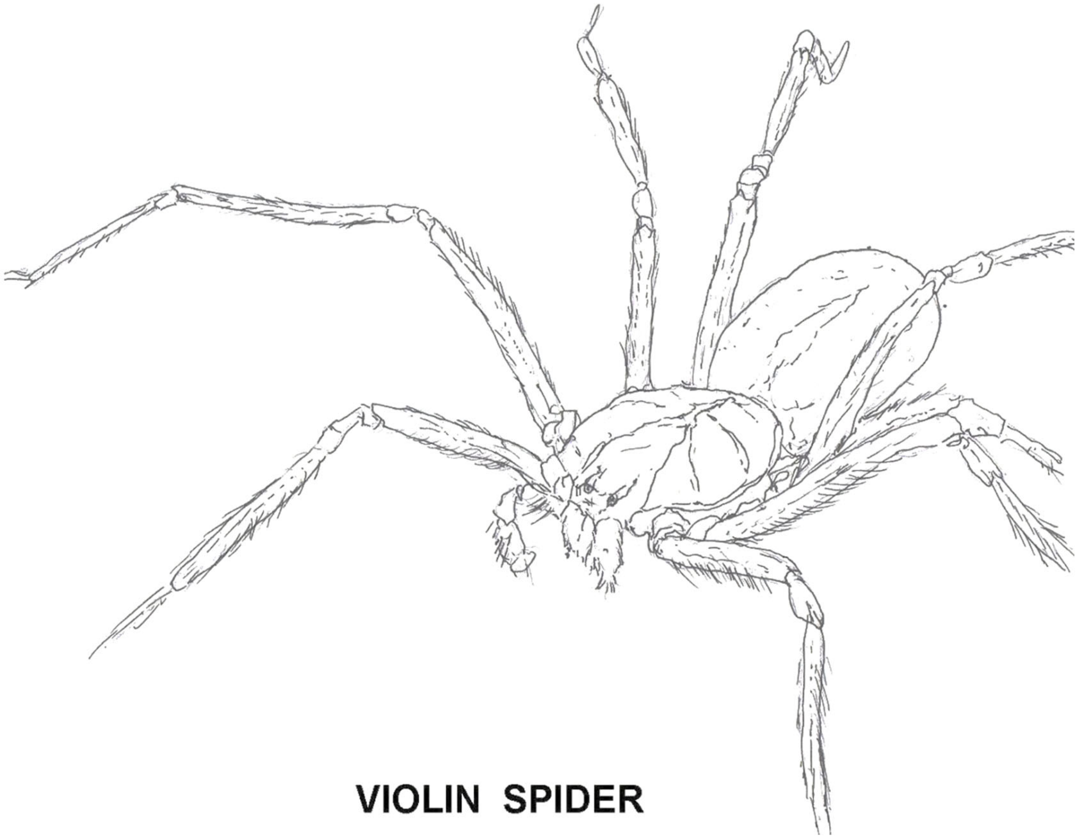
Violin Spiders – Human Biter
AKA Brown Recluse

VIOLIN SPIDER AKA BROWN RECLUSE

Family: Loxoscelidae (venomous six-eyed spiders) in the order Araneae (spiders)
Description: The name "violin spider" describes a characteristic marking on the brown recluse: there is a violin-shaped patch on the broad, almost heart-shaped cephalothorax (the head, as opposed to the abdomen). The overall color is usually a grayish-yellow-brown, the oblong abdomen covered with gray hairs. The legs are darker than the body and are long and slim. Females are larger than males. The webs are small, irregular, and untidy. These spiders are usually seen walking or running around, not in a web.

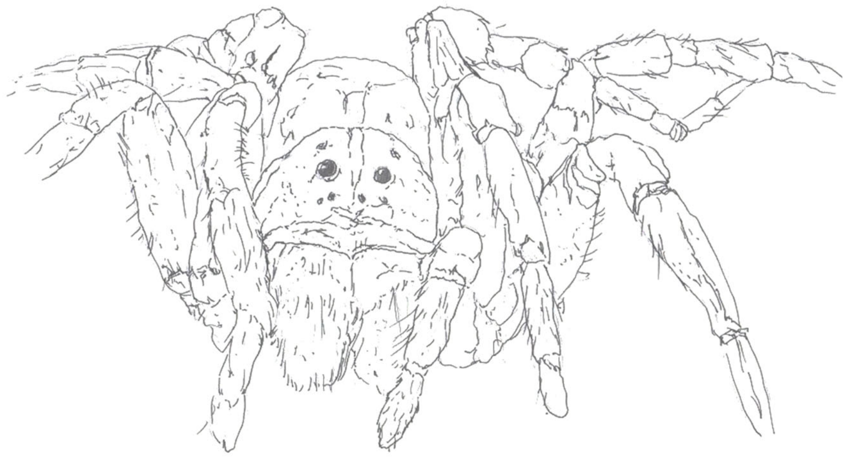
Size: Length: females to ¼ inch, not counting legs; including legs in a typical pose, they are about 1 inch long.

Some of the spiders in this group that can cause a nasty bite include the running spider, jumping spider, wolf spider, tarantula, sac spider, orbweaver spider and the northwestern brown spider, also known as the hobo spider.



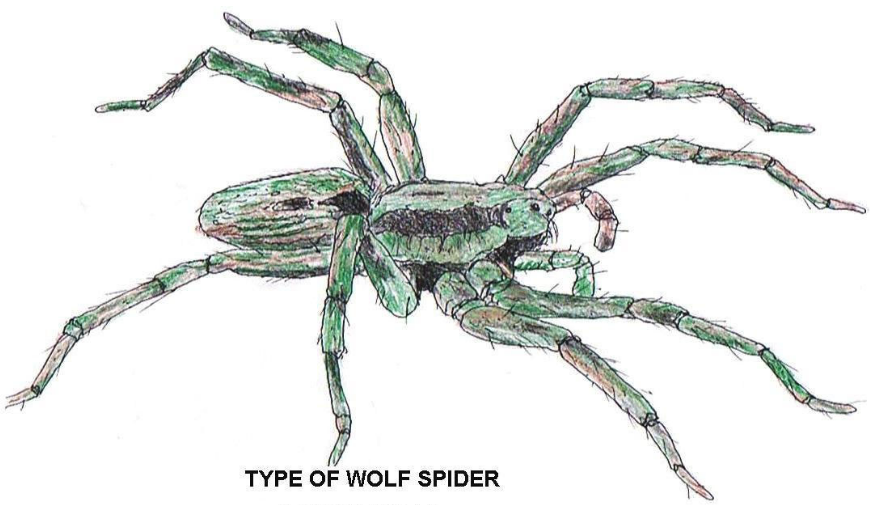
VIOLIN SPIDER

Wolf Spiders – Human Biters



LYCOSA ASPERSA

It has four simple eyes in a fairly straight first row and four larger simple eyes behind them at the vertices of a trapezoid. (The shorter of the two parallel sides of the trapezoid is just behind the row of four smaller eyes.) It is a large spider that has excellent vision and can run rapidly. It simply overpowers its prey. Also, it has considerable poise and is fearless. For instance, when a hand is placed flat on the ground beside the spider, it will permit itself to be nudged to move over, stand on the hand, and then remain completely motionless while the fingers of the hand remain outstretched and the hand is elevated upward while remaining horizontal. Wolf spiders like to look directly at the person who is observing them.



TYPE OF WOLF SPIDER
(Lycosa gulosa)

Is easily identified by her egg sac containing hundreds of unhatched eggs which is securely attached to her spinnerets; she can hunt efficiently with this arrangement. Female wolf spiders in this situation can become particularly fine mothers. Namely, after the individual spiders hatch from their eggs in this egg sac, they are gathered together and carried around on the back of the female spider. As she captures prey, she shares the food. Spiders can be considered particularly dainty eaters; it is as if they drink their food through soda straws.

WOLF SPIDER

Spider Bite Sub-Section

Spiders suffer an unsavory reputation, perhaps because of their appearance, their tendency to lurk in dark places or dangle ominously from a thread, and a gross exaggeration of their ability to poison humans. Some people are absolutely terrified at the mere sight of a spider, a condition known as arachnophobia.

Although all spiders have poison glands that they use for defense and to kill or paralyze prey, only about 30 of the 40,000 spider species produce venom that can cause serious illness in humans. Humans are more likely to be harmed by bee or wasp stings than by the relatively few spider species that can inflict a harmful bite.

Some of the spiders most dangerous to humans are the black widow spider, the brown recluse spider, the Australian funnelweb spider, and the South American hunting spider. Bites from these spiders can be fatal to humans without proper treatment. For instance, the bite of a black widow spider causes severe pain that may last for days. If not treated properly with an injection of calcium and a specific antivenin, a person may take weeks to recover, and in rare cases the bite may result in death.

Most spiders that are poisonous to humans prefer to avoid human contact and only bite when they feel threatened. The South American hunting spider is an exception—it is quite aggressive. Its bite is very painful, but it is rarely deadly for humans, most likely because the spider uses only a small amount of venom when it bites.

Although spiders pose minimal danger to humans, human activity seriously threatens some spider species. Such activities include habitat destruction, in which forestlands are destroyed for agriculture or for building homes and business developments. The widespread use of pesticides in agriculture targets specific insect pests but also kills harmless spiders and their insect prey. To protect spider populations, 16 spider species are included on the 2000 Red List of Threatened Species compiled by the World Conservation Union (IUCN), a nongovernmental organization that compiles global information on endangered species.

All spiders (except the family Uloboridae) have venom glands, but not all are venomous to man. In fact very few species pose a threat to man. Some spider bites might need medical attention even if the species is recognized as not being venomous to man, as secondary infections can occur. Spider venom, like snakebite venom, is generally either neurotoxic or cytotoxic. Generally, it is the web dwellers that have neurotoxic venom, and the non-web dwellers have the cytotoxic venom.

What are the symptoms of a bite from these kinds of spiders?
In most cases of bites from these spiders, there is pain or burning at the bite site in the first 10 minutes. The bite from this group is usually described as looking like a "target" or "bull's-eye." The center of the wound is usually a blister surrounded by a reddened area. A pale or blanched area may surround the discolored reddened area.

The blister may rupture, leaving an open ulcer. In severe cases the ulcer can become deep and infected causing tissue breakdown or tissue death (necrosis).

Worsening pain, itching and a burning sensation develop. A patient may also have symptoms such as a red, itchy rash over the torso, arms and legs that is usually seen in the first 24-72 hours. Patients may have pain in the muscles and joints, fever, chills, swollen lymph nodes, headaches, and nausea and vomiting.

How are these bites treated?
Frequently, when people with spider bites call the Poison Center, they think there is some special treatment that is necessary for their bite. There is no specialized therapy other than treating the symptoms. Most importantly, keep the wound clean to prevent infection. If the wound does not heal or does develop an infection, see your physician. Do not wait days and weeks while the wound continues to get worse.

There are tales of people having limbs amputated after spider bites. These involve people who refused to see a physician even though they had massive wounds that did not heal and became grossly infected. A wound that may have been originally treated with simple oral antibiotics, but left untreated, may require surgical intervention in extreme cases.

What else can cause a nasty looking wound?
Kissing bugs, fleas, bed bugs, flies, mites, wasps, ants and blister beetles have produced lesions similar to a brown recluse spider bite. Many skin disorders and medical conditions can produce lesions that can also mimic a brown recluse spider bite. Some of these include infected herpes outbreaks, bedsores, diabetic ulcers, poison oak and Lyme disease. Again, use common sense: If there is a wound that is not healing as expected or getting worse, see a physician.

Cytotoxic venom affects the cellular tissue, usually restricted to the area of the bite, but it can spread. The bite is at first painless, with symptoms developing about 2 to 8 hours after the bite. It starts by resembling a mosquito sting, becoming more painful and swollen. Eventually it ulcerates into a large surface lesion (up to 10 centimeters) that will require medical attention. This type of bite would result from members of the genera *Loxosceles* (family Sicariidae) and *Cheiracanthium* (family Miturgidae).

Treatment with antibiotics might be required to treat secondary infections. The wound will take between two and 4 weeks to heal, but the lesion might take months to improve. In some cases, ugly scarring might occur that might require plastic surgery.

Sac spider, *Cheiracanthium fulcatum*

Sac spider bite at 6 weeks.


Sac spider bite at 3 days. (Photo by A. Pollard)

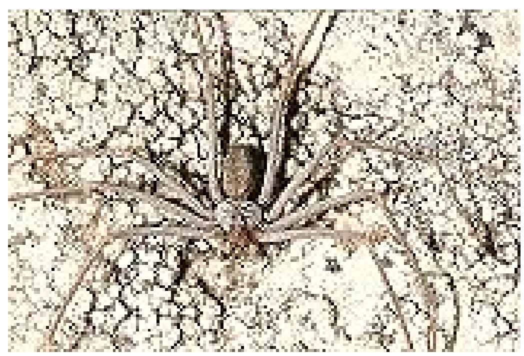

Sac spider bite at 10 days. (Photo by A. Pollard).


Sac spider bite.

More specifically, the bite of *Cheiracanthium* presents as two spots, 4-8 mm apart, where the fangs penetrated the skin and are yellow-green, the color of the venom. After 4 to 8 hours, mild inflammation, swelling and pain develop. A blister may form over the necrotic lesion after a few days.

After this sloughs, an irregular round, ulcerated wound of about 10mm remains. The wound is inflamed, swollen, and painful. The wound could start to heal after 10 days, but occasionally takes months. In some extreme cases, skin grafts have been necessary. The use of antibiotics is usually required should secondary infections set in, but this could be prevented by the use of an antibacterial cream, such as Betadine.

There is no anti-venom and an anti-tetanus injection is usually necessary. Some patients develop a mild fever and headaches after about 3 days, and the condition is sometimes misdiagnosed as tick bite fever. However, tick bite fever symptoms develop after about a 10 day incubation period after being bitten, by which stage the bite will have turned black and the surrounding area swollen and red. The venom of violin spider (Loxosceles) is also cytotoxic with similar symptoms to the sac spider.


Violin spider, *Loxosceles* sp.


Violin spider bite at 3 days.


Violin spider bite at 11 days.


Violin spider bite at 14 days.


Violin spider bite at 4 weeks.

Tissue damage from a bite by *Sicarius* (family Sicariidae) is far more extensive and severe. Bites to humans are not well documented. However, experimental rabbits died within 4-6 hours and autopsies revealed extensive damage to sub-dermal tissue and skeletal muscle. There was swelling of the liver and damage to heart and kidney tissue as well as blocked pulmonary arteries.
Not everyone will be affected in the same way by a spider bite. The severity would depend on the amount of venom injected, the health of the patient or if the patient has allergies, the age of the patient (small children and the elderly would be more adversely affected) and the site of the bite. Some patients display symptoms of stress that can be misleading, leading one to fear the worst of a harmless spider bite.

Neurotoxic venom affects the neuromuscular junctions, and bite symptoms involving this type of venom are:

- severe pain in the chest and abdomen.
- anxiety, raised blood pressure.
- breathing difficulties and heart palpitations.
- nausea and vomiting.
- sweating, excessive salivation, and watery eyes.
- the body temperature could either fall or rise above normal, and the blood pressure may rise with an increased pulse rate.
- a rash might develop.

In this venom category, it is only the back widow and the black button *Latrodectus indistinctus* bites that would require urgent medical attention, although *Latrodectus geometricus* envenomation will also require medical attention, especially in the case of children and the elderly.

The main signs and symptoms of Latrodectism
(Button spider envenomation):

- sharp burning pain at the site.
- pain spreads to lymph nodes within 15 minutes.
- severe muscle pain and cramps within an hour, resulting in tightness in the chest and difficulty with walking.
- anxiety, sweating, fever, slurred speech, nausea, and headaches.

Less than 5% of untreated cases result in death, usually as a result of respiratory failure. In fact, there have been no deaths from button spiders in the last 4 to 5 decades. Those more severely affected are children (smaller blood volume) and the elderly who might suffer respiratory or heart failure.

Symptoms are less severe with the brown button spider, *Latrodectus geometricus*. All *Latrodectus* bites should be treated and monitored.

When someone is bitten:

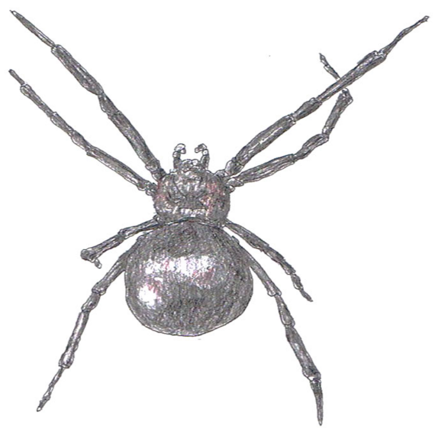
- Keep the culprit, if possible. An identification of the spider would be necessary to determine the appropriate treatment, if any.
- Keep the patient or the affected part as motionless as possible. However, this might not be practical if one is out in the wild. It is then preferable to get to help as soon as possible, even if the patient has to walk.
- Eating, drinking, and smoking should be avoided.
- Call for medical assistance.

- Keep the patient on his/her back with feet raised above the rest of the body. Cover with a blanket and keep the head to one side in case of vomiting.
- Loosen tight clothing.
- Apply artificial respiration should breathing stop.

Apply crushed ice to the affected area. The cold helps to retard the venom action and reduces pain. This must be done within minutes of being bitten. Do not cool for an extended period, and remove ice periodically for the feeling to return; otherwise, tissue damage might result.

DO NOT
- Use alcoholic drinks, as this could mask certain symptoms or exacerbate them.
- Use potassium permanganate on the wound.
- Cut the wound.
- Use a tourniquet, as this could aggravate local effects of the venom.
- Use snakebite venom antidote on spider bite and scorpion sting patients.

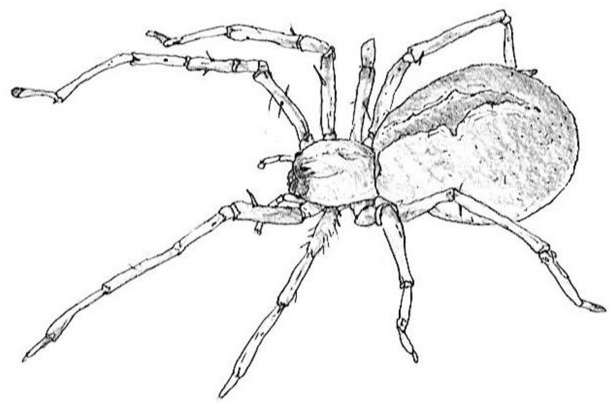
Seek medical attention if you think you have a spider bite. If possible, collect up the spider or what remains of it and take with you to your doctor or emergency clinic.



BLACK WIDOW SPIDER
(LATRODECTUS MACTANS)

The male black widow's abdomen is more elongated than that of the female, with white and red markings on its sides. The female's abdomen is almost spherical, usually with a red hourglass mark below or with 2 transverse red marks separated by black. The legs of the male are much longer in proportion to his body than those of the female. The female is more easily recognized, her shiny black body giving great contrast to the red hourglass marking on her round abdomen.

The black widow's range is from Massachusetts to Florida and west to California, Texas, Oklahoma and Kansas. Although they can be found in almost every state (and some portions of Canada), this spider is most common in the Southern locales of the United States. Black widow spiders are common around wood piles, and are frequently encountered when homeowners carry firewood into the house. Also found under eaves, in boxes, underneath unused construction materials, inside wooden toy boxes, firewood boxes, outdoor toilets, meter boxes, and other unbothered places.



SAC SPIDER
(Cheiraconthium mildei)

Sac Spiders (*Cheiracanthium*) These are wandering spiders that are found on vegetation and the ground. They are important predators of pests in gardens. They make their retreat sacs in folded leaves or grass blades. Sac spiders are light colored and have apparent spinnerets.

Necrotic Arachnidism – Spider Bites Part 2

Necrotic arachnidism is the potential cutaneous reaction to spider bite venom. In the United States, members of 7 spider families may be responsible for envenomation sufficiently severe to warrant treatment. Characteristics of several spiders, in particular Loxosceles spiders, whose bite is toxic to humans, are described, and diagnostic standards, preventive measures, and treatment options are reviewed.

NECROTIC ARAHNIDISM- SPIDER BITES

Necrotic arachnidism is a syndrome caused by the venom of certain spiders: Tegenaria agrestis (the hobo spider), Loxesceles reclusa (the brown recluse) and other Loxesceles species, and Cheiracanthrium spp. (yellow sac spiders). Latrodectus spp. (widow spiders) are also venomous, particularly the black widow spider, but cause a different set of symptoms.

HOBO SPIDER – HUMAN BITER

Recently, the Centers for Disease Control and Prevention (CDCP) reported that hobo spider bites are increasing in the Pacific Northwest. Also known as the aggressive house spider, the hobo spider causes a local reaction similar to that of the brown recluse; indeed, bites are often attributed to the brown recluse. But according to the CDCP, the brown recluse and other Loxesceles species are not found in the Pacific Northwest.

Hobo Spider

The hobo spider is large, brown with gray markings, and fast moving; it bites if provoked, according to the CDCP, especially the male during midsummer through fall when it wanders in search of a mate. It is native to Europe, was introduced into the Seattle area during 1920 to 1930, and has now spread as far as central Utah and the Alaskan panhandle. It builds funnel-shaped webs in dark, moist areas such as under wood piles, in crawl spaces, and along foundations. The spider doesn't climb, so is rarely found above basement or ground level.

The hobo spider bite is usually painless at first, according to the CDCP, but a hot, swollen, erythematous lesion with central blistering develops at the site of the bite, accompanied by nausea and severe headaches.

Lesions are characterized by induration (usually within 30 minutes), blistering (15-35 hours), and ulceration or necrosis with skin sloughing (within a week). Lesions usually heal in 45 days, but can require up to 3 years. Systemic symptoms include a severe headache (developing within a half hour or up to 10 hours after the bite, and lasting a week), nausea, weakness, fatigue, dizziness, temporary memory loss, and vision impairment. Serious side effects include aplastic anemia, intractable vomiting, and profuse watery diarrhea.

Chronic Arachnidism or Necrotic Arachnidism

While most spider bites are not dangerous, there is a group of spiders that can produce bite wounds that look similar to a brown recluse spider bite. Unless the spider was actually seen, captured and brought to the physician, the brown recluse spider is not likely to be the culprit.

Some of the spiders in this group that can cause a nasty bite include the running spider, jumping spider, wolf spider, tarantula, sac spider, orbweaver spider and the northwestern brown spider, also known as the hobo spider.

Validity of Necrosis Claims

It is estimated that 80% of reported brown recluse bites may be misdiagnosed. The misdiagnosis of a wound as a brown recluse bite could delay proper treatment of serious diseases. There is now an ELISA-based test for brown recluse venom that can determine whether a wound is a brown recluse bite, although it is not commercially available and not in routine clinical use; clinical diagnoses often use Occam's razor principle in diagnosing bites based on what spiders the patient likely encountered and what previous diagnoses are similar.

RUNNING SPIDER – HUMAN BITER

There are numerous documented infectious and noninfectious conditions (including pyoderma gangrenosum, bacterial infections by Staphylococcus and Streptococcus, herpes, diabetic ulcer, fungal infections, chemical burns, toxicodendron dermatitis, squamous cell carcinoma, localized vasculitis, syphilis, toxic epidermal necrolysis, sporotrichosis, and Lyme disease) that produce wounds that have been initially misdiagnosed as recluse bites by medical professionals; many of these conditions are far more common and more likely to be the source of mysterious necrotic wounds, even in areas where recluses actually occur.

The most important of these is methicillin-resistant Staphylococcus aureus ("MRSA"), a bacterium whose necrotic lesions are very similar to those induced by recluse bites, and which can be lethal if left untreated; misdiagnoses of MRSA as "spider bites" are extremely common (nearly 30% of patients later documented to have MRSA initially reported that they suspected a spider bite), and can have fatal consequences. In addition, published work has shown that tick-induced Lyme disease rashes are often misidentified as brown recluse spider bites.

Reported cases of bites occur primarily in Arkansas, Colorado, Kansas, Missouri, Nebraska, Oklahoma and Texas. There have been many reports of brown recluse bites in California (though a few related species may be found there and elsewhere outside the range of the brown recluse, none of these are known to bite humans).

To date the reports of bites from areas outside of the spider's native range have been either unverified, or—if verified—the spiders have been moved to those locations by travelers or commerce. Many arachnologists believe that many bites attributed to the brown recluse in the West Coast are not spider bites at all but possibly instead the bites of other spider species. For example, the bite of the hobo spider has been reported to produce similar symptoms, and is found in the northwestern United States and southern British Columbia. However, the toxicity of hobo spider venom has been called into question as bites have not been proven to cause necrosis, and this spider is not considered a problem in Europe.

Numerous other spiders have been associated with necrotic bites in medical literature. Other recluse species, such as the desert recluse (found in the desert southwestern United States), are reported to have caused necrotic bite wounds, though only rarely. Other spiders that have been reported to cause necrotic bites include the hobo spider and the yellow sac spiders. However, the bites from these spiders are not known to produce the severe symptoms that often follow from a recluse spider bite, and the level of danger posed by each has been called into question. So far, no known necrotoxins have been isolated from the venom of any of these spiders, and some arachnologists have disputed the accuracy of many spider identifications carried out by bite victims, family members, medical responders, and other non-experts in arachnology.

There have been several studies questioning danger posed by some of these spiders. In these studies, scientists examined case studies of bites in which the spider in question was positively identified by an expert, and found that the incidence of necrotic injury diminished significantly when "questionable" identifications were excluded from the sample set. (For a comparison of the toxicity of several kinds of spider bites, see the list of spiders having medically significant venom.)

Bite Treatment

First aid involves the application of an ice pack to control inflammation, the application of aloe vera to soothe and help control the pain, and prompt medical care. If it can be easily captured, the spider should be brought with the patient in a clear, tightly closed container so it may be identified. There is no established treatment for necrosis, though many claim to find pain relief, venom elimination, and even complete healing through the use of inexpensive active carbon (or charcoal) salves.

Routine treatment should include elevation and immobilization of the affected limb, application of ice, local wound care, and tetanus prophylaxis. Many other therapies have been used with varying degrees of success including hyperbaric oxygen, dapsone, antihistamines (e.g., cyproheptadine), antibiotics, dextran, glucocorticoids, vasodilators, heparin, nitroglycerin, electric shock, curettage, surgical excision, and antivenom. None of these treatments have been subjected to randomized controlled trials to conclusively show benefit. In almost all cases, bites are self-limited and typically heal without any medical intervention.

It is important to seek medical treatment if a brown recluse bite is reasonably suspected. In the rare cases of necrosis the effects can quickly spread, particularly when the venom reaches a blood vessel. Cases of brown recluse venom traveling along a limb through a vein or artery are rare, but the resulting tissue mortification can affect an area as large as several inches and in extreme cases require excising of the wound.

Other Spider Bites and Treatments

Jumping Spiders
The jumping spider is probably the most common biting spider in the United States. People are caught by surprise and scared when they see the spider jump, especially if it jumps towards them. Bites from a jumping spider are painful, itchy and cause redness and significant swelling. Other symptoms may include painful muscles and joints, headache, fever, chills, nausea and vomiting. The symptoms usually last about 1-4 days.

Wolf Spiders
Wolf spiders are commonly found in California. They are large hairy spiders, up to 3-4 inches across. They are a mottled gray-brown color, which helps them hide in sand, gravel, leaves and other debris. Female wolf spiders carry their young on their backs. Except for one group, wolf spiders do not spin webs. They tend to burrow into the earth and hide.

They are aggressive, come after their prey and are fast runners. Because of their impressive size and aggressiveness, wolf spiders can easily incite panic. Bites from a wolf spider can cause pain, redness and swelling. The large jaws/fangs can cause a tear in the skin as they bite. Swollen lymph glands may develop. The skin area at the bite may turn black. Swelling and pain can last up to ten days.

Tarantulas
Tarantulas are also large hairy spiders. In fact, some people call any large hairy or fuzzy spider a tarantula. Tarantulas are very hairy with sharp bristles. The hairs are easily shed or can be rubbed off. Handling a tarantula can result in irritation to the skin. If hands are not washed after handling a tarantula and eyes are touched, the sharp hairs can cause eye irritation that may require a trip to the physician.

Tarantulas are sensitive to vibrations and hunt at night by touch. If cornered, the tarantula will make a purring sound and may rear up on its back legs. Even though tarantulas are scary looking to most people, most bites do not produce any significant poisoning symptoms. However, the bites can be quite painful because of the large size of the spider. Wash your hands well with soap and water after handling a tarantula.

Northwestern Brown Spider or the Hobo Spider
The northwestern brown spider or hobo spider (Tegenaria agretis) is well known in Oregon and Washington and is also quite common in Utah. Spider bites by this spider are becoming recognized more often in California, which may be due to the fact that the spider is becoming better known. The hobo spider often causes a bite that leaves an open, slow-healing wound. Bites from this spider are frequently and mistakenly thought to be brown recluse spider bites.

Keep the wound clean and prevent infection. If the bite becomes infected or does not seem to heal, see a physician.

Daddy Longlegs Spiders
The Daddy Longlegs is not a true spider in that it cannot make silk and does not have fangs or venom glands. Daddy Longlegs have long thin legs with flexible claw-like "fingers". Daddy Longlegs can pinch but rarely penetrate human skin. They have scent glands on the front part of their bodies that can give-off a bad-smelling fluid. This stinky fluid is used as a defense mechanism to keep enemies away.

Some people might have a reaction to the fluid but Daddy Longlegs are not considered dangerous to humans. Daddy Longlegs are usually found hanging upside down in corners, eaves or basements. They are very common and are found in most homes. Because they eat insects and other spiders, they are considered beneficial.

Bug Bites and Stings

Bug bites and stings usually are just nuisances. They bring momentary alarm, temporary discomfort and pain, but no serious or lasting health problems. But on occasion, they can cause infections that require treatment and allergic reactions that can be serious, even fatal.

Parents should know the signs of an infection or allergic reaction and when to get medical attention. Inform all caregivers if a child has any history of complications so they know what to do in the event of a bug bite or sting.

What to Do About:
Bee and Wasp Stings

- A bee will leave behind a stinger attached to a venom sac. Try to remove it as quickly as possible. (Wasps don't leave their stingers in the skin after stinging, which means they can sting more than once.)
- Wash the area carefully with soap and water. Do this two to three times a day until the skin is healed.
- Apply an ice pack wrapped in a cloth or a cold, wet washcloth for a few minutes.
- Give acetaminophen or ibuprofen for pain.
- For pain and itching, give an over-the-counter oral antihistamine if your child's doctor says it's OK; follow dosage instructions for your child's age and weight. You could also apply a corticosteroid cream or calamine lotion to the sting area.
- A sting anywhere in the mouth warrants immediate medical attention because stings in oral mucous membranes can quickly cause severe swelling that may block airways.
- Seek medical care if you notice a large skin rash or swelling around the sting site, or if swelling or pain persists for more than 3 days, which could indicate an infection.
- Get medical help right away if you notice any of the following signs, which may indicate a serious or potentially life-threatening allergic reaction:
    - wheezing or difficulty breathing
    - tightness in throat or chest
    - swelling of the lips, tongue, or face
    - dizziness or fainting
    - nausea or vomiting

Spider Bites

- Wash the area carefully with soap and water. Do this two to three times a day until skin is healed.
- Apply cool compresses.
- Give acetaminophen or ibuprofen for pain.
- To protect against infection, apply an antibiotic ointment and keep the child's hands washed.

If you have any reason to suspect a bite by a black widow or brown recluse spider, apply ice to the bite site and take your child to the emergency room. Even if a child doesn't show any symptoms, get medical attention right away.

Most spiders found in the United States are harmless, with the exception of the black widow and the brown recluse spider. The brown recluse spider — a tiny oval brown spider with a small shape like a violin on its back — is found mostly in midwestern and southern parts of the United States. The bites usually don't hurt at first, and a child might not even be aware of the bite, but in some cases they cause swelling and changes in skin color and a blister.

The black widow spider, which is found all over North America, has a shiny black body and an orange hourglass shape on its underbelly. The venom (poison) in a black widow bite can cause painful cramps that show up within a few hours of the bite. The cramps can start in the muscles around the bite and then spread. The bite may also lead to nausea, vomiting, chills, fever, and muscle aches. If your child has any of these symptoms — or you know that he or she has been bitten — go to the emergency room right away.

In the southwest United States, an unidentified “bite” may be caused by a scorpion sting. Take your child to the emergency room immediately.

Tick Bites
Check kids and pets for ticks carefully after you've been in or around a wooded area. Common types of ticks include dog ticks and deer ticks (deer ticks may be carriers of Lyme disease).

If you find a tick on your child:

- Call your doctor, who may want you to save the tick after removal (you can put it in a jar of alcohol to kill it).
- Use tweezers to grasp the tick firmly at its head or mouth, next to the skin.
- Pull firmly and steadily on the tick until it lets go, then swab the bite site with alcohol.
- Don't use petroleum jelly or a lit match to kill and remove a tick.

Reviewed by: Elana Pearl Ben-Joseph, MD

Web Spiders Post Quiz

Fill-in-the blank

Orb Weaving Spiders
1. Venom toxicity - the bite of Orb-Weaving Spiders is of low risk (not toxic) to humans. They are a non-aggressive group of spiders, ________________________.

Trap-Door Spiders
2. Venom toxicity - the bite of the Trap-Door Spider is of __________to humans. It is a non-aggressive spider - usually timid but may stand up and present its fangs if harassed. Rarely bites - but if so it can be painful.

House Spider
3. The common house spider belongs to the funnelweb spiders in the family Agelenidae in the suborder Araneomorphae. House spiders are found throughout Europe and North America. This spider is so named because its ___________is often seen in wall corners of houses, but it can also be found in any cool, dark place, such as dense vegetation or crevices of logs or rocks.

4. Spider venom, like______________________, is generally either neurotoxic or cytotoxic. Generally, it is the web dwellers that have neurotoxic venom, and the non-web dwellers have the cytotoxic venom.

What are the symptoms of a bite from these kinds of spiders?
5. In most cases of bites from these spiders, there is pain or burning at the bite site in the first 10 minutes. The bite from this group is usually described as looking like a ________________.

6. Worsening pain, itching and a burning sensation develop. A patient may also have symptoms such as a red, itchy rash over the torso, arms and legs that is usually seen in the first_________________. Patients may have pain in the muscles and joints, fever, chills, swollen lymph nodes, headaches, and nausea and vomiting.

What else can cause a nasty looking wound?
7. ____________________, fleas, bed bugs, flies, mites, wasps, ants and blister beetles have produced lesions similar to a brown recluse spider bite. Many skin disorders and medical conditions can produce lesions that can also mimic a brown recluse spider bite. Some of these include infected herpes outbreaks, bedsores, diabetic ulcers, poison oak and Lyme disease. Again, use common sense: If there is a wound that is not healing as expected or getting worse, see a physician.

8. **Cytotoxic venom affects the cellular tissue,** usually restricted to the area of the bite, but it can spread. The bite is at first painless, with symptoms developing about _______________after the bite. It starts by resembling a mosquito sting, becoming more painful and swollen.

9. Treatment with antibiotics might be required to treat secondary infections. The wound will take between _______________to heal, but the lesion might take months to improve. In some cases ugly scarring might occur that might require plastic surgery.

Jumping Spiders

10. The jumping spider is probably the most common biting spider in the United States. People are caught by surprise and scared when they see the spider jump, especially if it jumps towards them. Bites from a jumping spider are painful, itchy and cause redness and significant swelling. Other symptoms may include painful muscles and joints, headache, fever, chills, nausea and vomiting. The symptoms usually last about ________________.

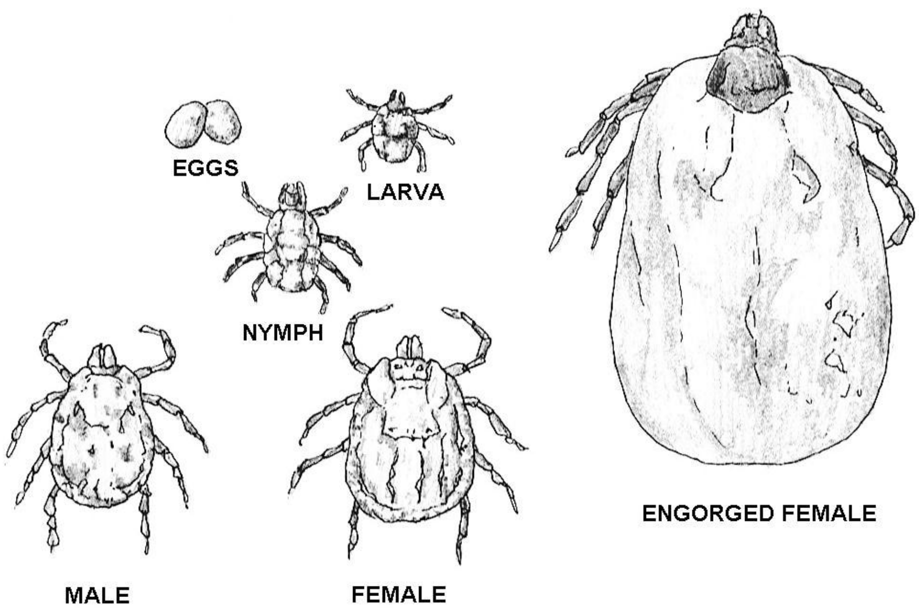
Web Spiders Post Quiz Answers

1. Seldom bite,2. Low risk (non-toxic), 3. Horizontal sheet web, 4. Snakebite venom, 5. "Target" or "bull's-eye", 6. 24-72 hours, 7. Kissing bugs, 8. 2 to 8 hours, 9. Two and 4 weeks, 10. 1-4 days

Topic 12 – Tick Section

Section Focus: You will learn the basics of ticks and related blood-feeding insects. At the end of this section, you will be able to understand and describe ticks. You will learn about the tick family class, genera, life cycle and related subjects. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Ticks are representatives of the order Ixodida, which constitute a large group of arthropods of major medical and veterinary importance. They are obligate blood feeders and some species act as vectors of various viruses, bacteria, protozoa and helminths to many animal species, including humans. Out of over 50,000 named species of Acari, approximately ~ 970 are tick species. The order Ixodida is presently subdivided into four families: Ixodidae (~ 750 spp.), Argasidae (~ 218 spp.), Nuttalliellidae (monotypic) and Deinocrotonidae (monotypic, but extinct). Tick species of medical and veterinary importance are included in the families Argasidae (soft ticks) and Ixodidae (hard ticks), which are the principal focus of this section.



VARIOUS STAGES AND SIZES OF COMMON HARD TICKS

The term "**Tick**" is the commonly used name for the small arachnids, closely related to scorpions, spiders and mites. These are <u>not</u> insects. These highly designed and specialized creatures live on blood of mammals, birds, and occasionally reptiles and amphibians. Ticks are vectors of a number of diseases, including Lyme disease, tick-borne meningoencephalitis, tick paralysis, to name a few, but most tick bites do not result in illness. Incredibly, more than 800 species of these obligate blood-feeding creatures inhabit the planet. They are <u>second</u> only to mosquitoes as vectors of human disease, both infectious and toxic. We at TLC enjoy studying ticks, and have many species of ticks. Our primary tick keeper Duke considers these creatures his "pets". We hope you will enjoy this course.

Arachnida
The order Acarina (class Arachnida) includes mites and ticks. Members of this order differ from other arachnids in that the body is not segmented, and the cephalothorax and abdomen are combined into one body region. Larval mites and ticks have three pairs of legs, whereas nymphs and adults have four pairs.

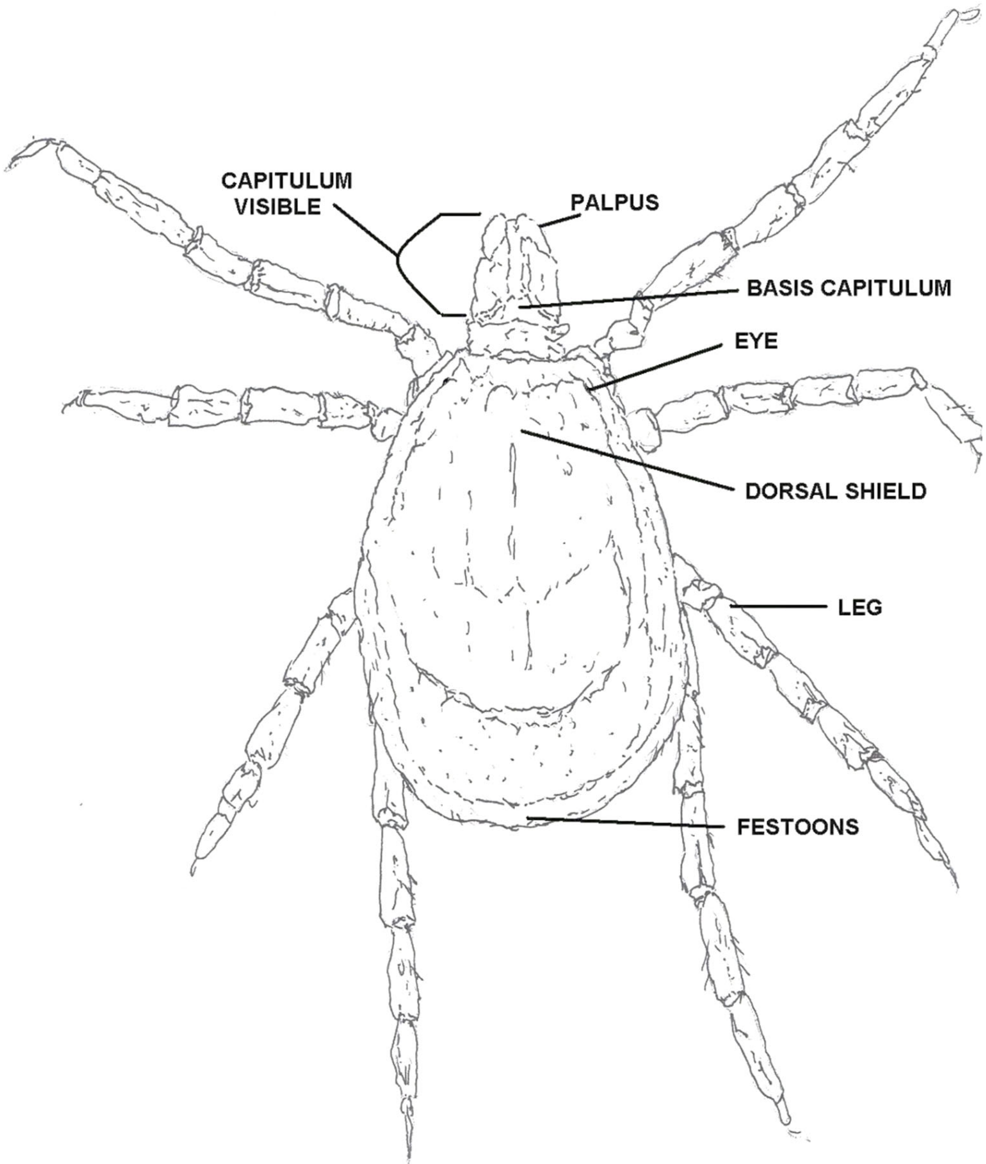
Mites (More on these in the rear of course)
Mites inhabit most ecological settings, ranging from deserts to rain forests, mountain tops to tundra and saltwater ocean floors to freshwater lakes. The relatively few species parasitic on humans in the U.S. produce dermatitis, often followed by allergic reactions.

ROCKY MOUNTAIN TICK

Ticks Life Cycle
Ticks are parasitic during their life cycle. They are annoying pests whose bites are irritating. When a tick is forcibly removed, its mouthparts frequently remain in the skin, resulting in a sore, an infection or even blood poisoning. In the US, ticks, unlike mites, transmit many serious diseases. Ticks are external parasites on mammals, birds, reptiles, and amphibians. Both males and females feed on blood.

This topic section will describe the biology and management of five species of ticks commonly found. These ticks are all species which vector a disease, are capable of transmitting a pathogen to humans, or may in some other way affect human health.

They are the Lone Star tick, *Amblyomma americanum* (L), American dog tick, *Dermacentor variabilis* (Say), Rocky Mountain wood tick, *Dermacentor andersoni* (Stiles), deer tick, *Ixodes dammini* (Spielman, Clifford, Piesman, and Corwin), and *Ornithodoros* spp.



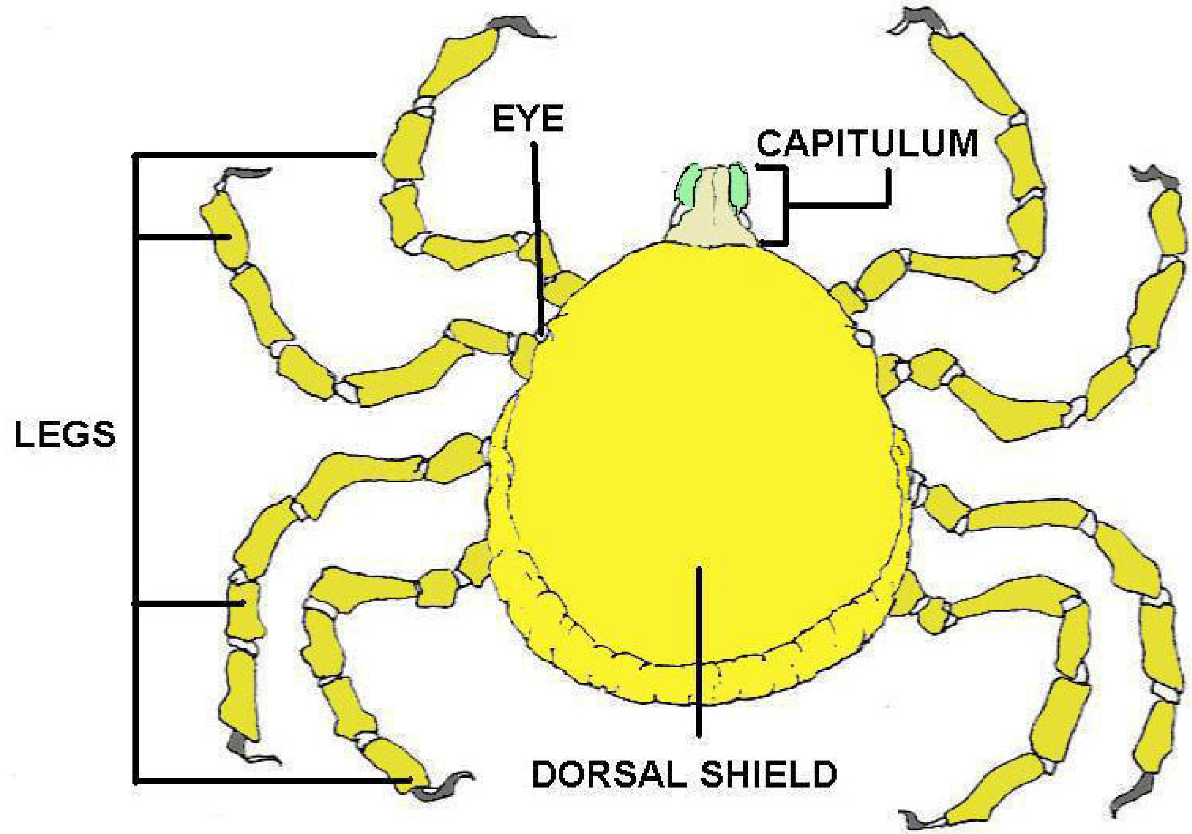
Unfed Adult Stage Characteristics

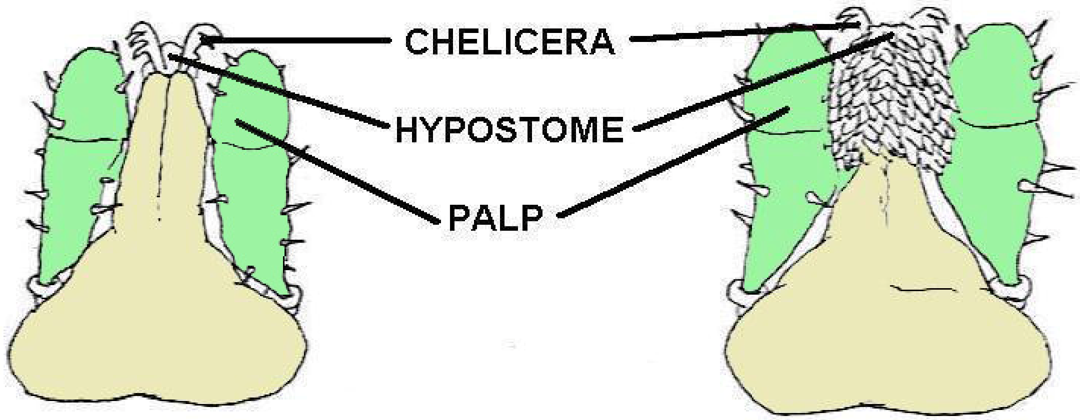
Scutum (shield) Pattern
Ticks have a dorsal scutum or "shield" and each species has a unique pattern or color. *Ixodes* ticks often have a black/brown solid colored scutum. Whereas, *Dermacentor* and *Amblyomma* ticks each have a patterned scutum.

Festoons
Festoons are small areas separated by short grooves on the back margin of the tick and helps distinguish all other ticks from Ixodes ticks, which lack festoons.

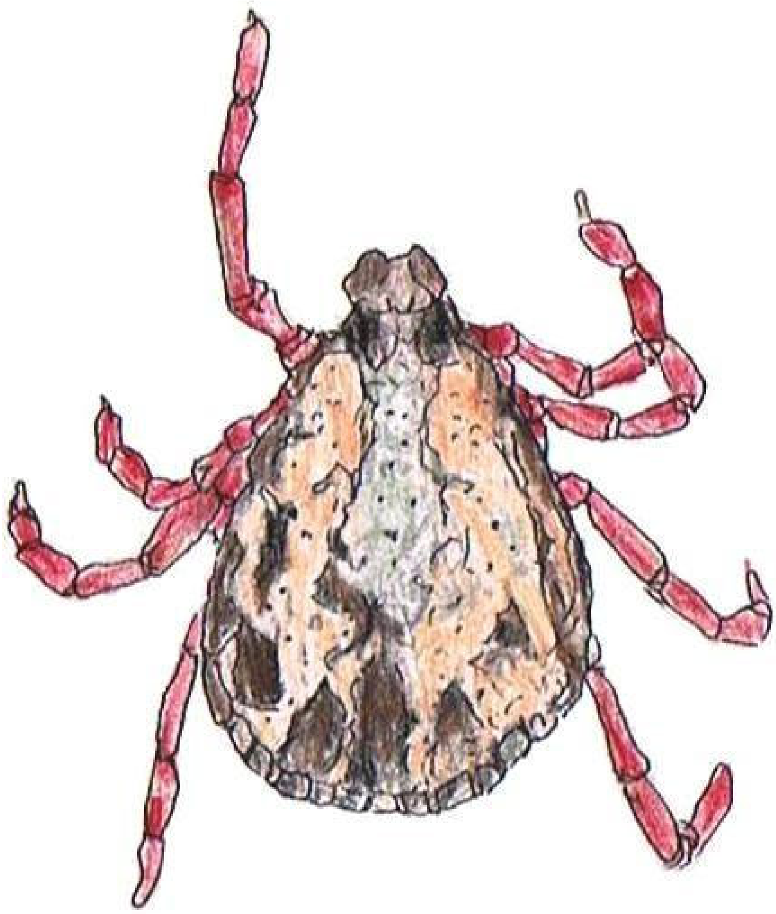
AMERICAN DOG TICK
HARD TICK

TICK ANATOMY DIAGRAMS





TICK MOUTH PARTS

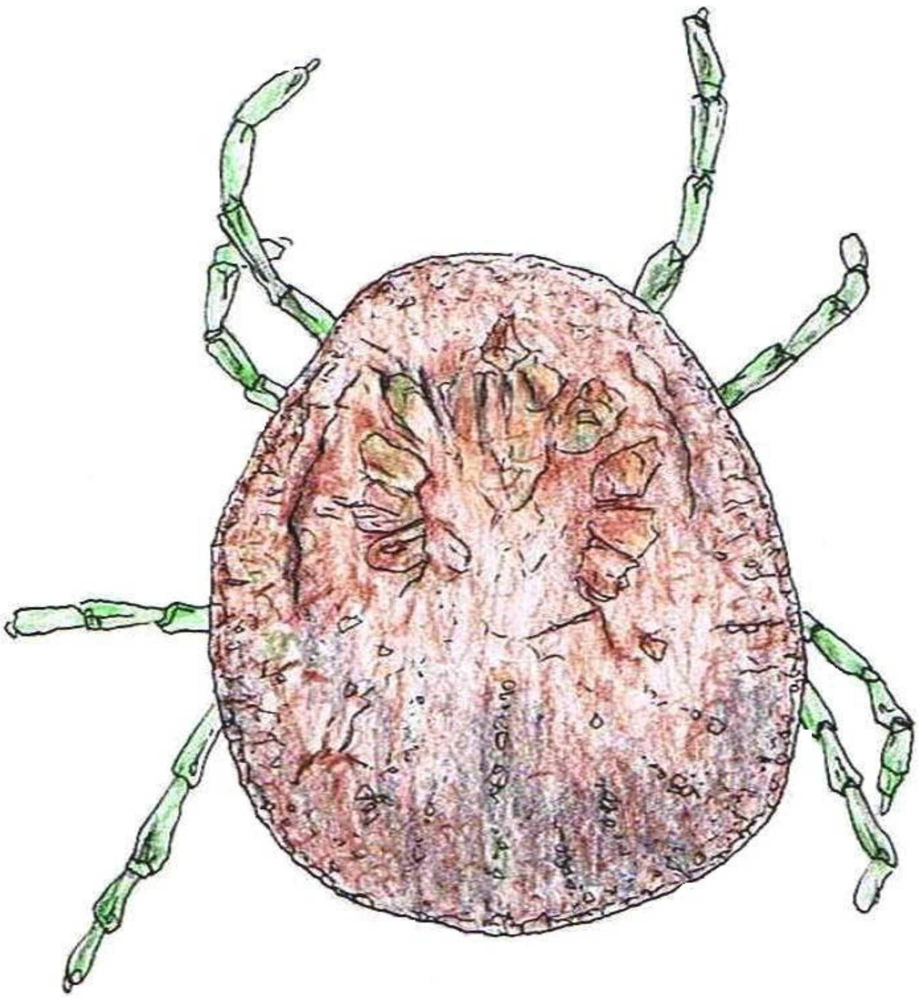


HARD TICK EXAMPLE

Ixodidae or **Hard Ticks** (>700 species) are distinguished from the Argasidae by the presence of a *scutum* or hard shield. This shield makes the force of a human's shoe, or footwear insufficient to crush the tick. However, an engorged tick, filled with blood, can easily be killed by stepping on it. In Ixodidae nymphs and adults, a prominent *capitulum* (head) projects forwards from the body; in the Argasidae, conversely, the *capitulum* is concealed beneath the body.

Ixodid ticks require three hosts, and their life cycle takes at least one year to complete. Up to 3,000 eggs are laid on the ground by an adult female tick. When larvae emerge, they feed primarily on small mammals and birds.

After feeding, they detach from their host and molt to nymphs on the ground, which then feed on larger hosts and molt to adults. Female adults attach to larger hosts, feed, and lay eggs, while males feed very little and occupy larger hosts primarily for mating

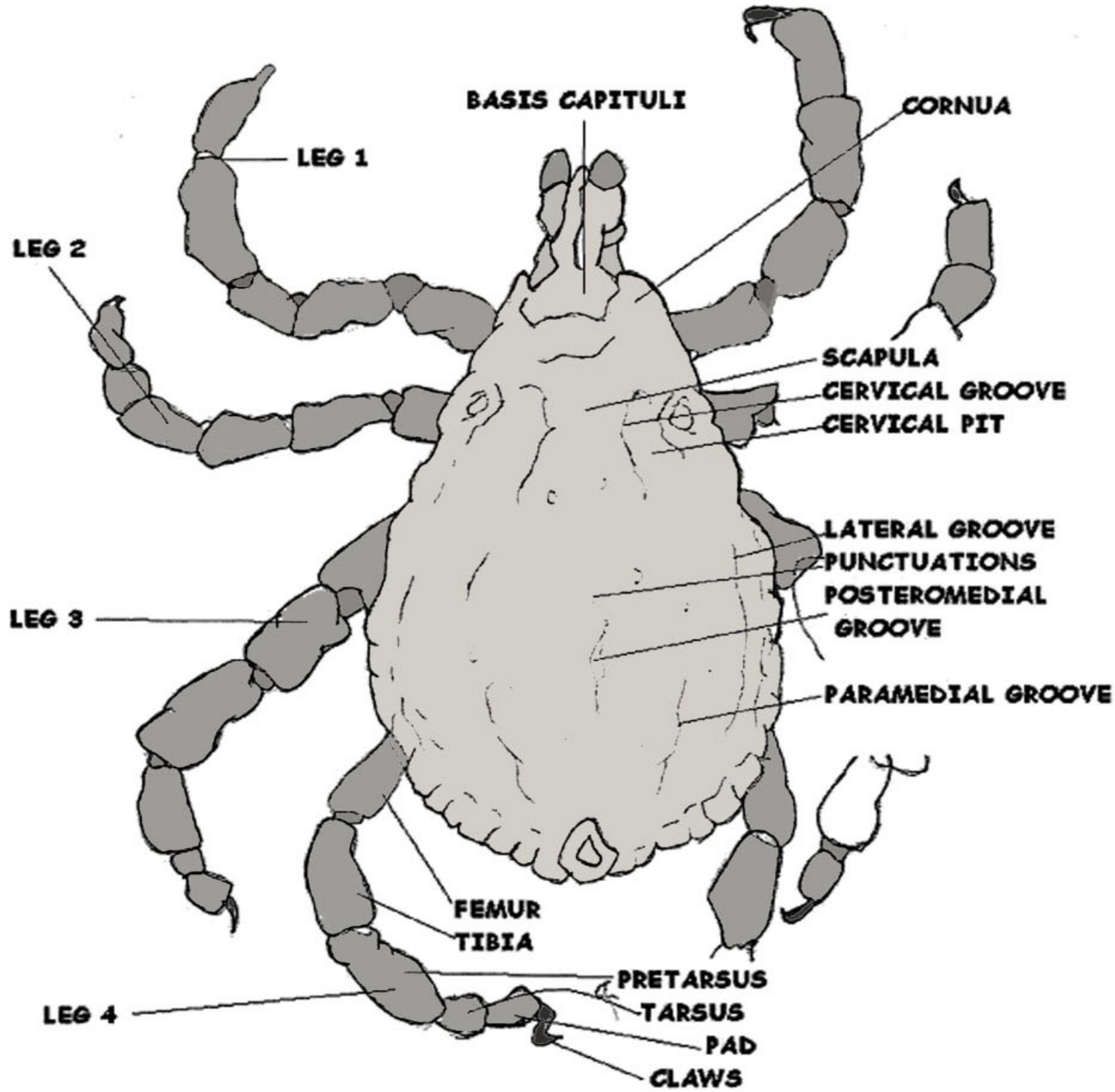


SOFT TICK EXAMPLE

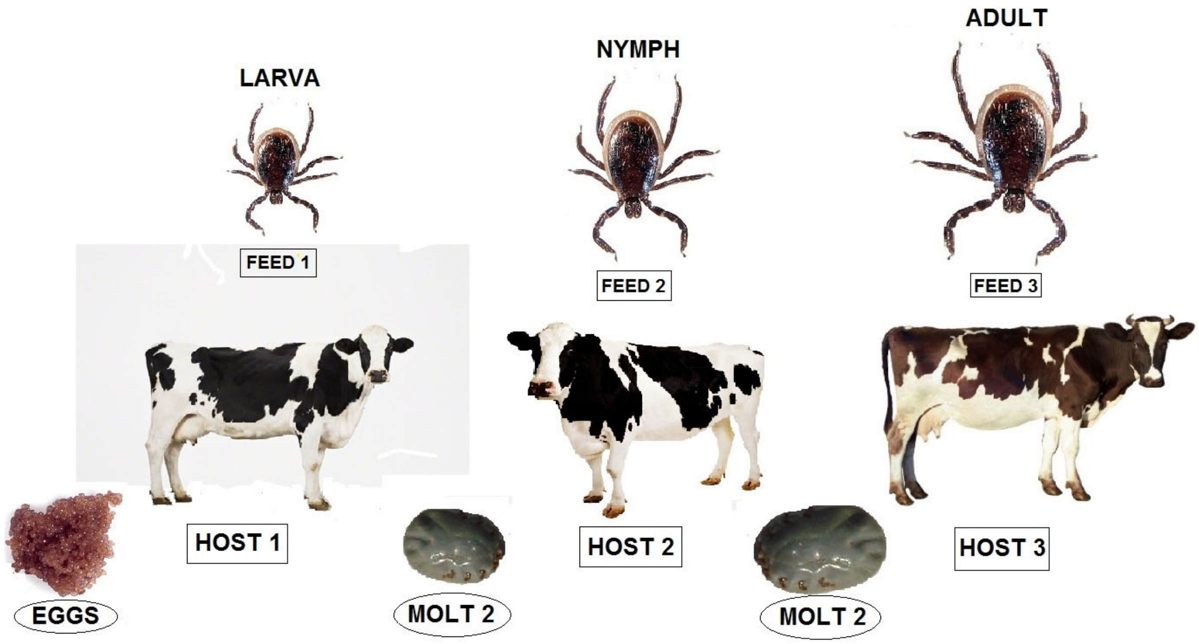
The **Argasidae** or Soft Ticks contain 193 species, although the composition of the genera is less certain, and more study is needed before the genera can become stable. The currently accepted genera in 2010 are *Antricola*, *Argas*, *Nothaspis*, *Ornithodoros*, and *Otobius*.

Though common in North America, they feed rapidly, primarily on birds, and are very rarely found to parasitize land mammals or humans.

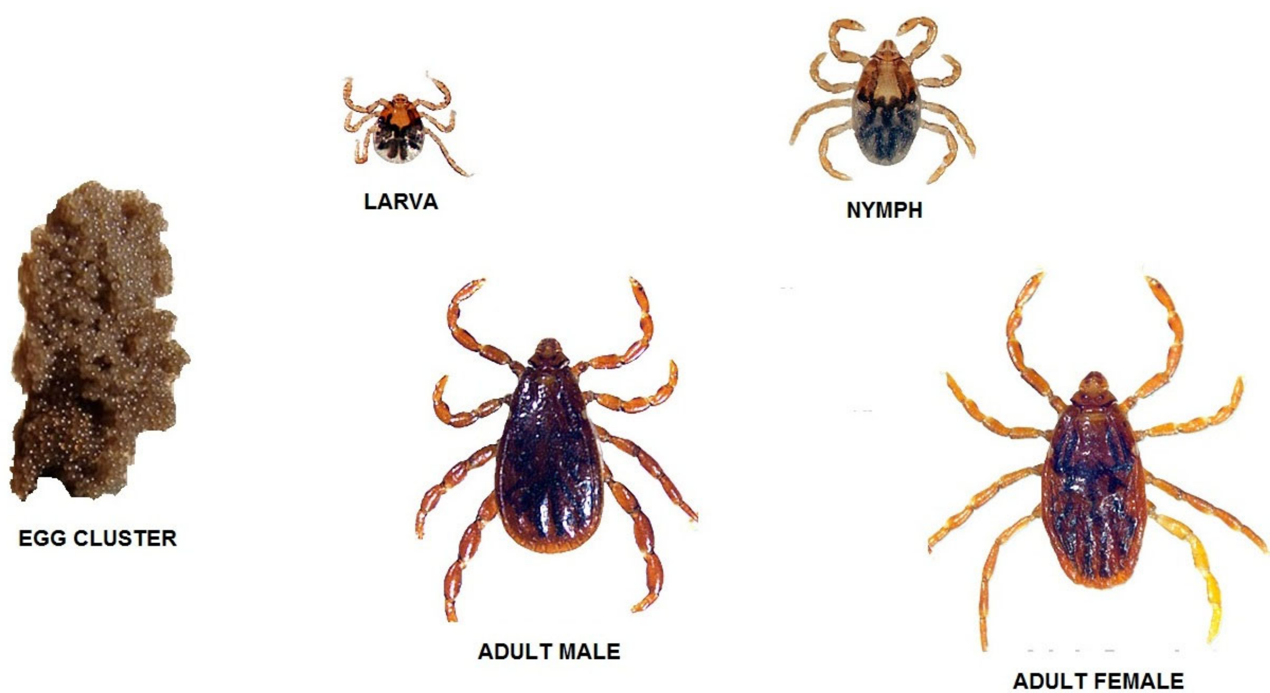
Soft ticks have no hard shell (Scutum). In the United States, only ticks of the genus *Ornithodoros* transmit human disease, namely, relapsing fever. The biology of soft ticks differs from that of hard ticks in that meals last for only short periods (<1 hour), and disease can be transmitted in less than 1 minute.


BASIS CAPITULI
CORNUA
LEG 1
LEG 2
SCAPULA
CERVICAL GROOVE
CERVICAL PIT
LATERAL GROOVE
PUNCTUATIONS
POSTEROMEDIAL GROOVE
LEG 3
PARAMEDIAL GROOVE
FEMUR
TIBIA
PRETARSUS
LEG 4
TARSUS
PAD
CLAWS

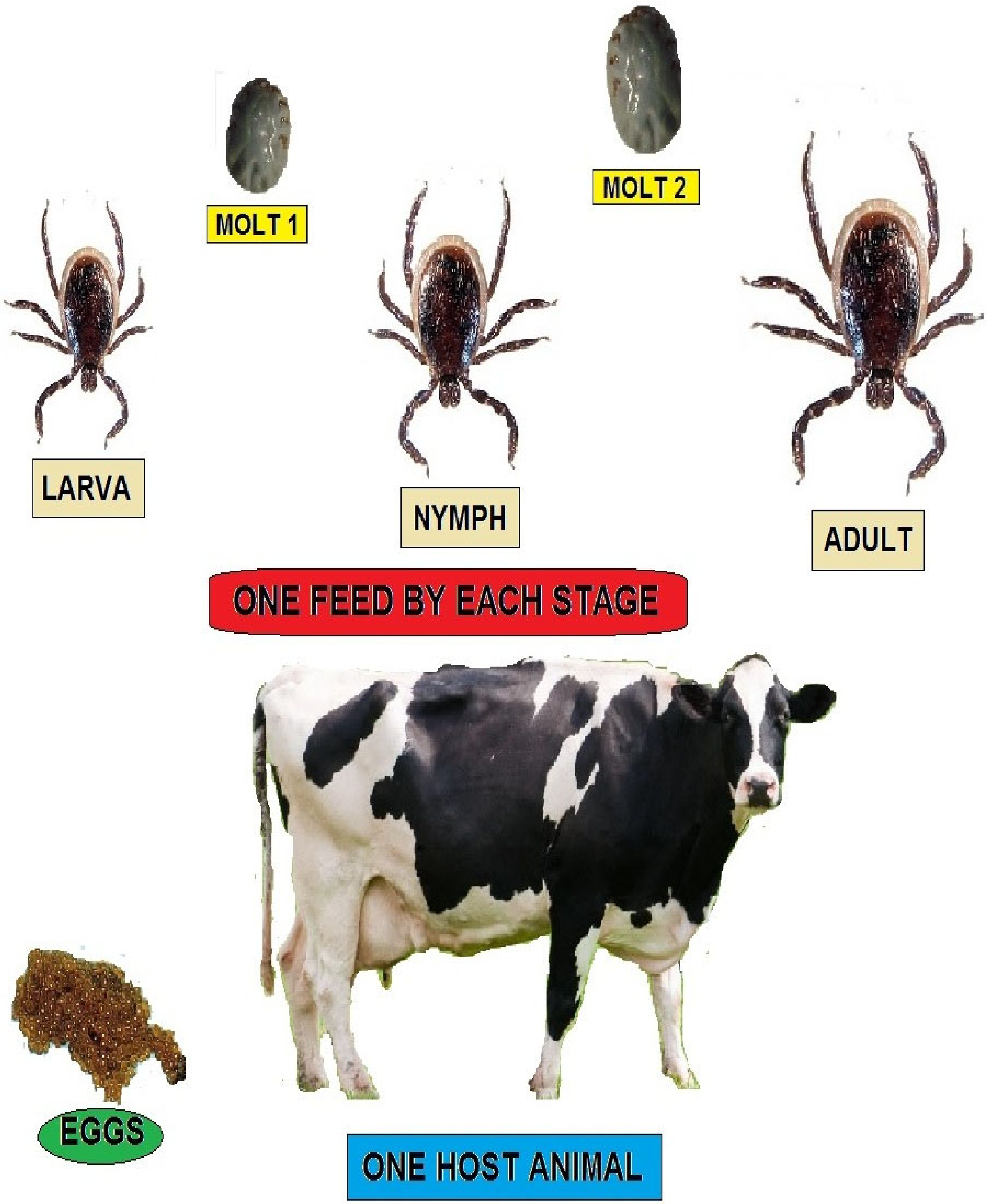
TICK LIFE CYCLE DIAGRAMS



3-HOST LIFE-CYCLE OF A HARD TICK



AMERICAN DOG TICK STAGES DIAGRAM



ONE-HOST LIFE-CYCLE OF A HARD TICK DIAGRAM

Ticks are Parasites

Tick Facts
Ticks can only crawl; they cannot fly or jump. Ticks found on the scalp have usually crawled there from lower parts of the body. Some species of ticks will crawl several feet toward a host. Ticks can be active on winter days when the ground temperatures are above 45 degrees Fahrenheit.

DEER TICK

There are two groups of ticks, sometimes called "hard" ticks and "soft" ticks. Hard ticks, like the common dog tick and Deer tick, have a hard shield just behind the mouthparts (sometimes incorrectly called the "head"); unfed hard ticks are shaped like a flat seed. Soft ticks do not have the hard shield and they are shaped like a small raisin. Soft ticks prefer to feed on birds or bats and are seldom encountered unless these animals are nesting or roosting in an occupied building.

Life Cycle and Reproduction
Both ixodid and argasid ticks undergo three primary stages of development: larval, nymphal, and adult.

Ixodidae
Ixodid ticks require three hosts, and their life cycle takes at least one year to complete. Up to 3,000 eggs are laid on the ground by an adult female tick. When larvae emerge, they feed primarily on small mammals and birds. After feeding, they detach from their host and molt to nymphs on the ground, which then feed on larger hosts and molt to adults. Female adults attach to larger hosts, feed, and lay eggs, while males feed very little and occupy larger hosts primarily for mating.

Argasidae
Argasid ticks, unlike ixodid ticks, may go through several nymphal stages, requiring a meal of blood each time. Their lifecycles range from months to years. The adult female argasid tick can lay a few hundred to over a thousand eggs over the course of her lifetime. Larvae feed very quickly and detach to molt to nymphs.

ARGASIDAE TICK

Nymphs may go through as many as seven instars, each requiring a blood meal. Both male and female adults feed on blood, and they mate off the host. During feeding, any excess fluid is excreted by the coxal glands, a process which is unique to argasid ticks.

Ticks and Mites

Ticks of domestic animals directly cause poor health and loss of production to their hosts by many parasitic mechanisms. Ticks also transmit numerous kinds of viruses, bacteria and protozoa between domestic animals. These microbes cause diseases which can be severely debilitating or fatal to domestic animals, and may also affect humans.

Ticks are especially important to domestic animals in tropical and subtropical countries. Here the warm climate enables many species of ticks to flourish. Also the large populations of wild animals in warm countries provide a reservoir of ticks and infective microbes that spread to domestic animals. Farmers of livestock animals use many methods to control ticks and there are related treatments to reduce infestation of companion animals. Veterinarians and animal health agencies work at private, national and international scales to reduce the harm caused by ticks and their associated diseases

Some mites are parasitic but all ticks are parasitic feeders on blood. Some species of mites may be mistaken for larval ticks at infestations but their feeding mechanisms are distinctive. All ticks have an incomplete metamorphosis: after hatching from the egg a series of similar stages (instars) develop from a six legged larva, to eight legged nymph and then a sexually developed eight legged adult.

Between each stage there is a molt (ecdysis) which enables the developing tick to expand within a new external skeleton. Ticks are grouped in three families of which two have genera of importance to domestic animals, as follows.

The family Argasidae contains the important genera Argas, Ornithodoros and Otobius. These genera are known as soft ticks because their outer body surface lacks hard plates. The family Ixodidae contains the important genera Amblyomma, Dermacentor, Haemaphysalis, Hyalomma, Ixodes, Margaropus, and Rhipicephalus. Also the important boophilid ticks, formerly of the genus Boophilus, are now classified as a sub-genus within the genus Rhipicephalus.

ORNITHODOROS TICK

RHIPICEPHALUS TICK

These genera are known as hard ticks because their outer surface has hard plates. Within these 10 genera there are, very approximately, 100 species of importance to domestic animals. Some of these species are also important to humans. The only countries that do not have some kind of problem with ticks on domestic animals are those that are permanently cold.

Ticks satisfy all of their nutritional requirements as ectoparasites, feeding on a diet of blood in a practice known as hematophagy. They are obligate hematophages, needing blood to survive and move from one stage of life to another. Ticks unable to find a host to feed on will die.

Ticks extract the blood by cutting a hole in the host's epidermis, into which they insert their hypostome, in order to keep the blood from clotting by excreting an anticoagulant or platelet aggregation inhibitor.

Ticks find their hosts by detecting animals' breath and body odors, or by sensing body heat, moisture and vibrations. They are incapable of flying or jumping, but many tick species wait in a position known as "questing". While questing, ticks hold onto leaves and grass by their third and fourth pair of legs. They hold the first pair of legs outstretched, waiting to climb on to the host. When a host brushes the spot where a tick is waiting, it quickly climbs onto the host.

Some ticks will attach quickly while others will wander looking for thinner skin like the ear. Depending on the species and the life stage, preparing to feed can take from ten minutes to two hours. On locating a suitable feeding spot, the tick grasps the skin and cuts into the surface

Three Main Families of Ticks

Of the three families of ticks, one – Nuttalliellidae – comprises a single species, *Nuttalliella namaqua*. The remaining two families contain the hard ticks (Ixodidae) and the soft ticks (Argasidae). Ticks are closely related to the numerous families of mites, within the subclass Acarina.

Ixodidae (>700 species) are distinguished from the Argasidae by the presence of a *scutum* or hard shield. This shield makes the force of a human's shoe, or footwear insufficient to crush the tick. However, an engorged tick, filled with blood, can easily be killed by stepping on it. In Ixodidae nymphs and adults, a prominent *capitulum* (head) projects forwards from the body; in the Argasidae, conversely, the *capitulum* is concealed beneath the body.

The **Argasidae** contain 193 species, although the composition of the genera is less certain, and more study is needed before the genera can become stable. The currently accepted genera in 2010 are *Antricola*, *Argas*, *Nothaspis*, *Ornithodoros*, and *Otobius*. Though common in North America, they feed rapidly, primarily on birds, and are very rarely found to parasitize land mammals or humans.

NITTALLIELLIDAE TICK ON SNAKE

The family **Nuttalliellidae** contains only a single species, *Nuttalliella namaqua*, a tick found in southern Africa from Tanzania to Namibia and South Africa. It can be distinguished from ixodid ticks and argasid ticks by a combination of characteristics, including the position of the stigmata, lack of setae, strongly corrugated integument, and the form of the fenestrated plates

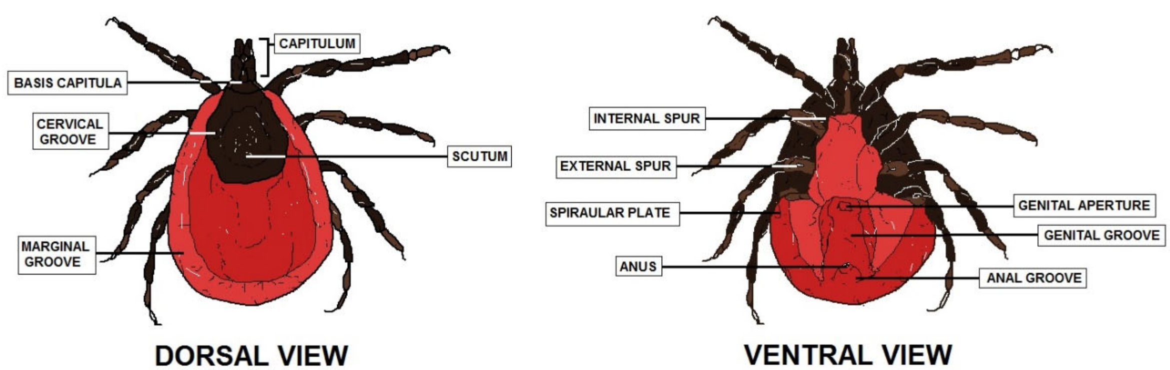
Range and Habitat
Tick species are widely distributed around the world, but they tend to flourish more in countries with warm, humid climates, because they require a certain amount of moisture in the air to undergo metamorphosis, and because low temperatures inhibit their development from egg to larva. Ticks of domestic animals are especially common and varied in tropical countries, where they cause considerable harm to livestock by transmission of many species of pathogens and also causing direct parasitic damage.

For an ecosystem to support ticks, it must satisfy two requirements: the population density of host species in the area must be high enough, and humidity must be high enough for ticks to remain hydrated. Due to their role in transmitting Lyme disease, ixodid ticks, particularly *I. scapularis*, have been studied using geographic information systems (GIS), to develop predictive models for ideal tick habitats. According to these studies, certain features of a given microclimate – such as sandy soil, hardwood trees, rivers, and the presence of deer – were determined to be good predictors of dense tick populations.

Anatomy and Physiology
Ticks, like mites, have bodies which are divided into two primary sections: the anterior *capitulum* (or *gnathosoma*), which contains the head and mouthparts; and the posterior *idiosoma* which contains the legs, digestive tract, and reproductive organs.

Tick Morphology
The body of a tick consists of a "false head" (the capitulum) and a thorax and abdomen fused into a single oval, flattened body. A larval tick has six legs, while nymphs and adults have eight legs present. The basal segment of the leg, the coxa, may have spurs that help in identification. An adult tick will have a genital aperture on the ventral surface, located roughly between the second pair of legs. The respiratory system is evident by spiracular plates located ventrolaterally behind the fourth pair of legs in the nymphs and adults. These plates may be oval, rounded, or comma-shaped.

Hard ticks get their name from a tough dorsal shield or plate called the scutum present on all mobile stages of the tick. The scutum on the larva, nymph, and female tick covers the dorsal anterior third to half of the body. By contrast, the scutum on a male tick covers almost the entire dorsal surface and expansion during feeding is very limited.



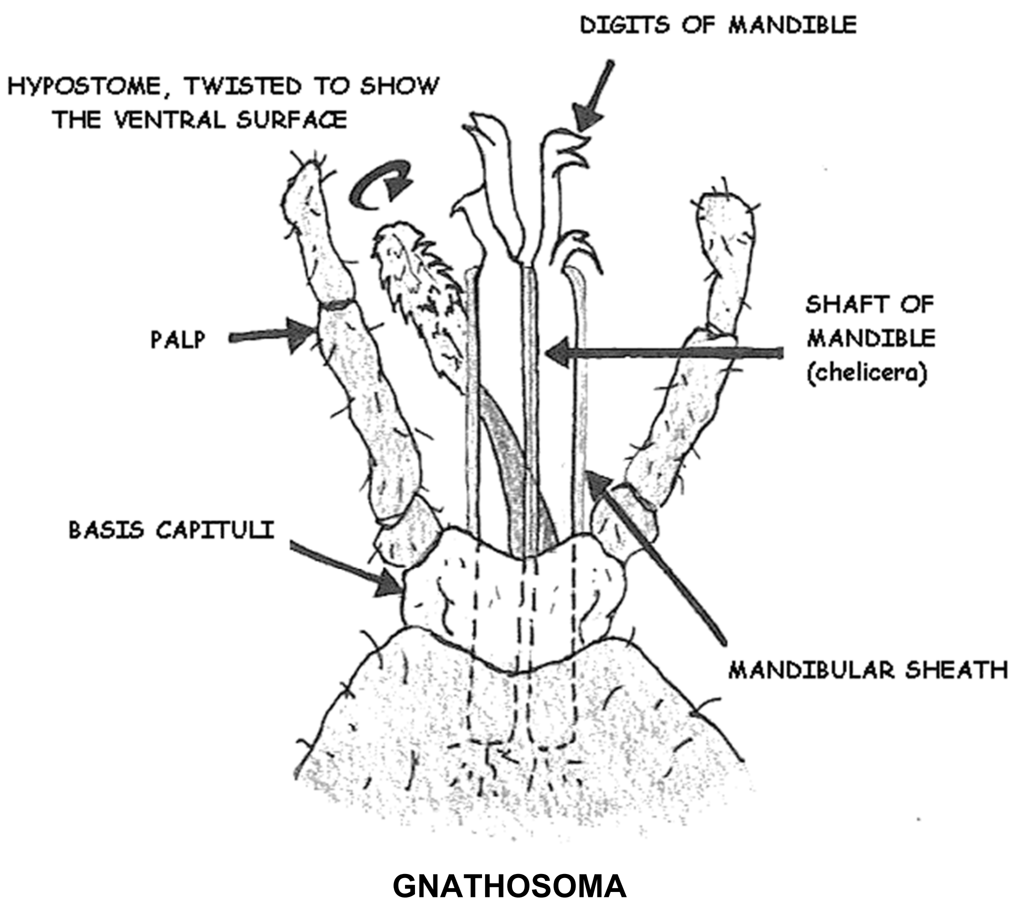
BASIC PARTS OF A TICK

The scutum differs in shape and others characteristics (i.e., presence or absence of simple eyes) between tick genera. In some ticks, ornate or patterned markings may be present that can aid in identification.

A distinct semicircular anal groove curves around the front of the anal opening in *Ixodes* ticks. In all other ticks, the anal groove is behind the anus or absent. Many ticks, but not *Ixodes*, have rectangular areas separated by grooves on the posterior margin of the tick body called festoons. Festoons, if present, may not be visible on fully engorged females. Argasid ticks are leathery, wrinkled and grayish in appearance. The capitulum of soft ticks is located on the underside of the body and cannot be seen from above.

The capitulum in hard ticks is visible dorsally in all stages. The capitulum holds the mouthparts consisting of a base (basis capituli), two palps, paired chelicerae, and the median ventral hypostome, which is covered with denticles or recurved teeth.

The shape of the basis capituli, length of the palps, number of denticles, and other characteristics of the mouthparts are used to help identify tick genera and species. While the adults of some common ticks can be easily identified with a little training because of distinctive markings or color, the identification of most ticks and the immature stages requires the services of a trained entomologist and the use of keys developed by tick taxonomists. These keys are designed to specifically identify adults, nymphs or larvae.



GNATHOSOMA

Diet and Feeding Behaviors

Ticks satisfy all of their nutritional requirements as ectoparasites, feeding on a diet of blood in a practice known as hematophagy. They are obligate hematophages, needing blood to survive and move from one stage of life to another. Ticks unable to find a host to feed on will die.

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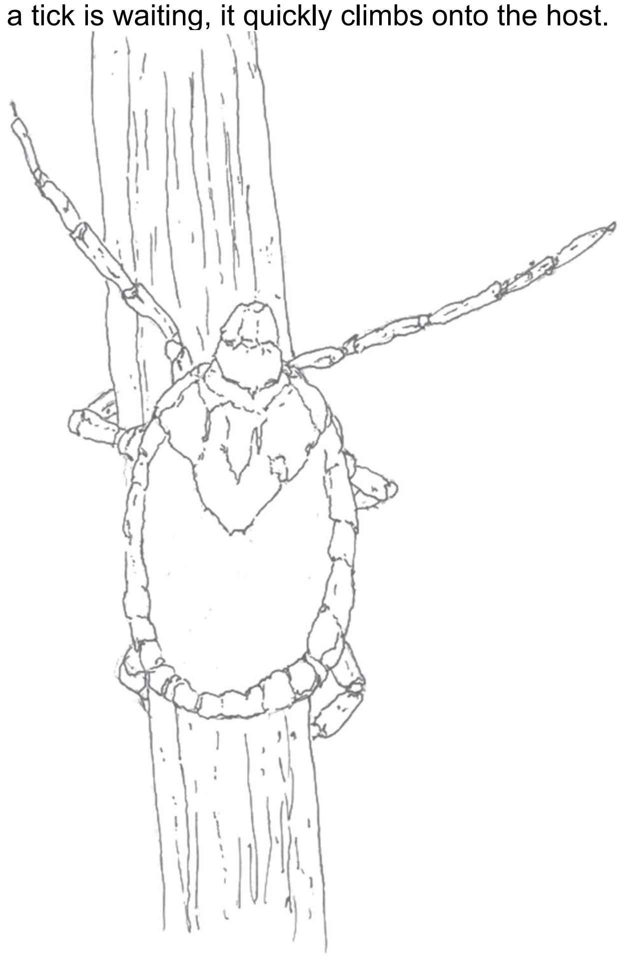
Ticks find their hosts by detecting animals' breath and body odors, or by sensing body heat, moisture and vibrations.

They are incapable of flying or jumping, but many tick species wait in a position known as "questing". While questing, ticks hold onto leaves and grass by their third and fourth pair of legs. They hold the first pair of legs outstretched, waiting to climb on to the host. When a host brushes the spot where a tick is waiting, it quickly climbs onto the host.



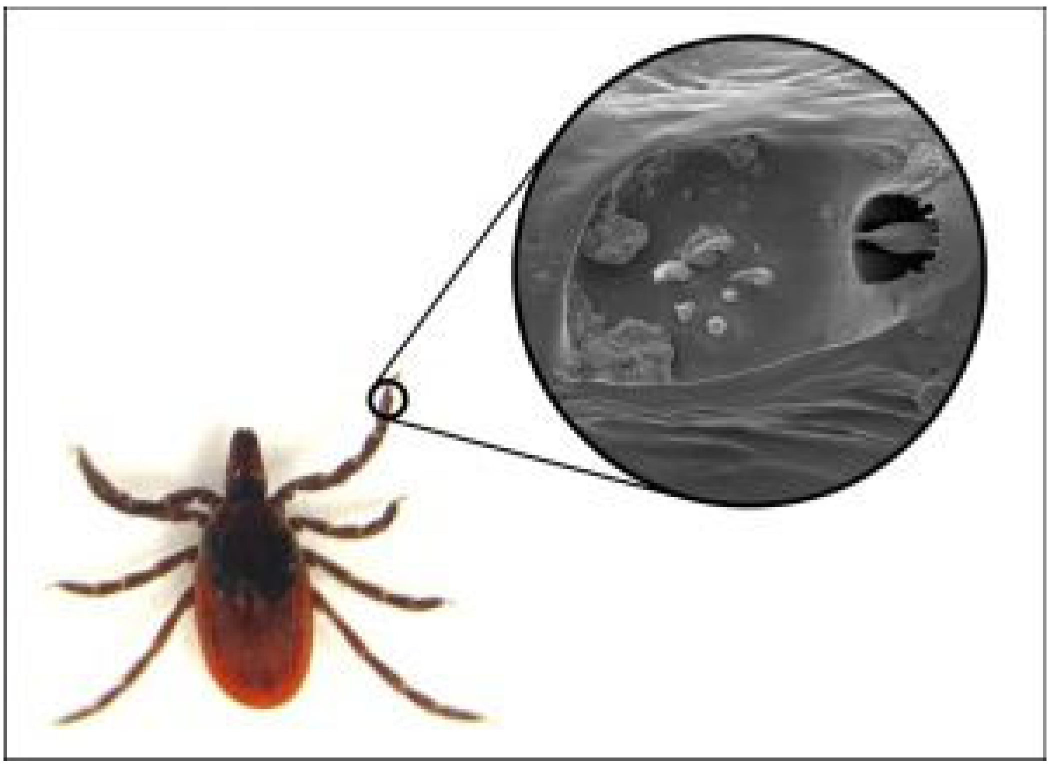
TICK "QUESTING" EXAMPLE

Some ticks will attach quickly while others will wander looking for thinner skin like the ear. Depending on the species and the life stage, preparing to feed can take from ten minutes to two hours. On locating a suitable feeding spot, the tick grasps the skin and cuts into the surface.

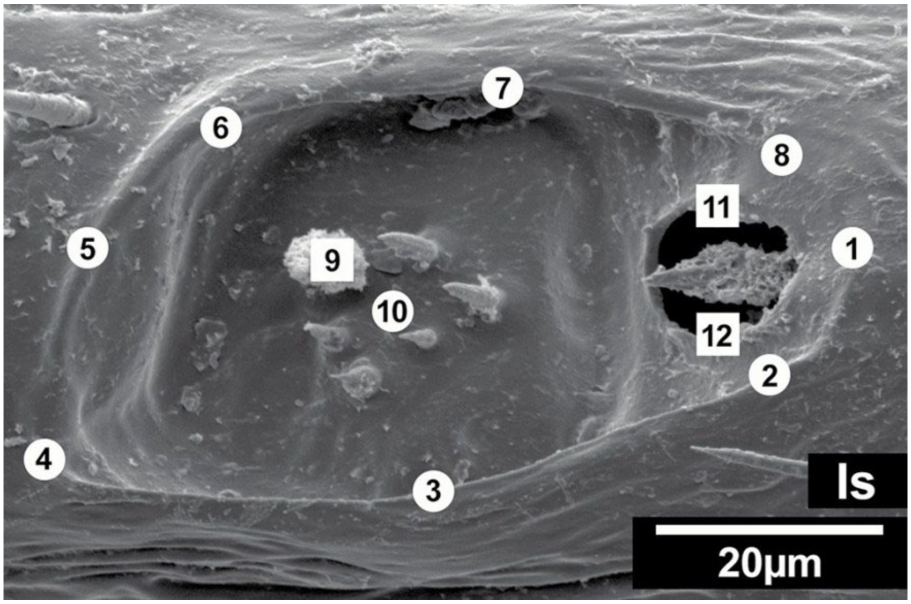
Legs
Like all arachnids, adult ticks have eight legs. The legs of Ixodidae and Argasidae are similar in structure. Each leg is composed of six segments: the coxa, trochanter, femur, patella, tibia, and tarsus. Each of these segments is connected by muscles which allow for flexion and extension, but the coxae have limited lateral movement. When not being used for walking, the legs remain tightly folded against the body. Larval ticks hatch with six legs, acquiring the other two after a blood meal and molting into the nymph stage.

Haller's Organ

In addition to being used for locomotion, the tarsus of leg 1 contains a unique sensory organ, the Haller's organ, which can detect odors and chemicals emanating from the host, as well as sensing changes in temperature and air currents.



HALLER'S ORGAN CLOSE-UP #1



HALLER'S ORGAN CLOSE-UP #2

Tick Feeding

The term tick bite may be misleading as ticks do not bite and depart or feed rapidly like a mosquito. Ticks attach and feed gradually over a period of several to many days. Once a tick has found a suitable place to feed, it grasps the skin, tilts the body at a 45-60° angle, and begins to cut into the skin with the paired chelicerae. The palps splay outwards on the skin surface. After the chelicerae and hypostome penetrate the skin, they become encased in "cement" secreted by the tick. The cement serves to hold the mouthparts in place while the tick feeds. Mouthparts on larval and nymphal ticks are small with less penetration and produce a smaller host reaction.

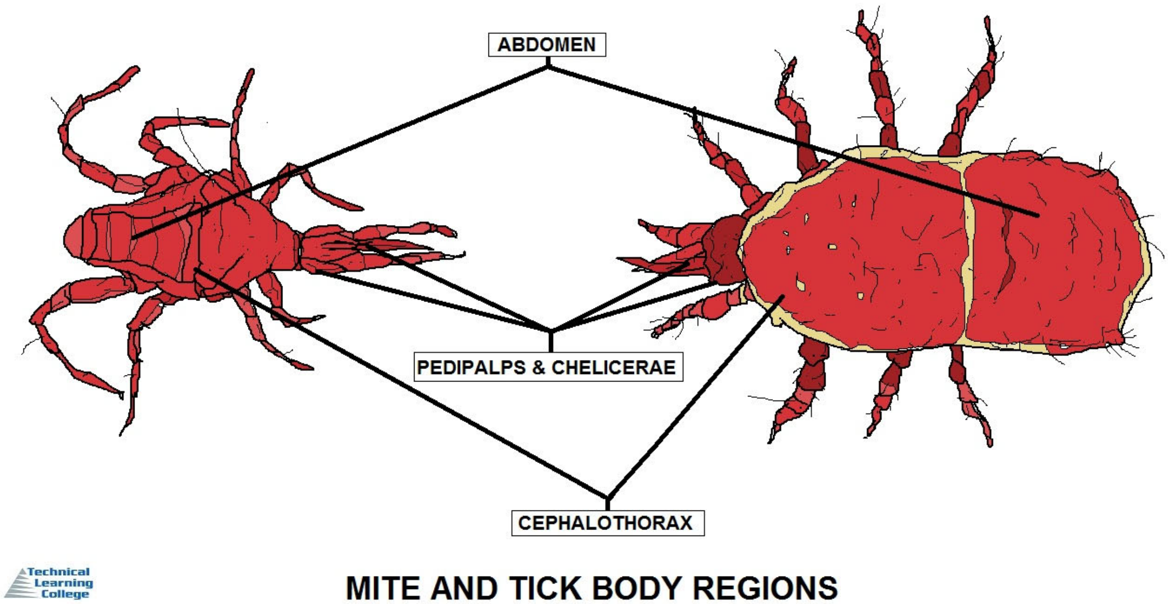
Adult *Ixodes* and *Amblyomma* ticks have long mouthparts that can reach the sub dermal layer of skin, produce a larger reaction, and make the tick harder to remove. Insertion of the mouthparts often takes around 10-30 minutes, but can take longer (1-2 hours). The reaction to a feeding tick may make the tick appear imbedded, but only the slender mouthparts actually penetrate the skin.

A variety of pharmacologically active compounds that aid the feeding process and possibly increase pathogen transmission are introduced in the tick's saliva (e.g., blood platelet aggregation inhibitors, anticoagulants, anti-inflammatory and immunosuppressive enzymes, and vasodilators to increase blood flow). Feeding is not continuous and most of the blood meal is taken up during the last 12-24 hours of feeding. The body weight of a feeding female tick can increase 80-120 times. Male ticks are intermittent feeders, take smaller amount of blood, and do not change appreciably in size (male *I. scapularis* do not need to feed and are rarely found attached). The probability of transmission of Lyme disease spirochetes increases the longer an infected tick is attached.

Ticks feed by perching in low vegetation and waiting for a susceptible host on which they can attach and feed. Once on a host, the tick attaches its hypostome, a central piercing element with hooks, into the host's skin.

Some ticks secrete a cementing material to fasten themselves to the host. In addition, *Ixodes* ticks secrete anticoagulant, immunosuppressive, and anti-inflammatory substances into the area of the tick bite. These substances presumably help the tick to obtain a blood meal without the host's noticing.

These same substances also help any freeloading pathogens to establish a foothold in the host. From the perspective of disease transmission to humans, the essential characteristic of ticks is their need to ingest a blood meal to transform to their next stage of development. Not picky in their eating habits, they take their requisite blood meal from all classes of vertebrates (e.g., mammals, reptiles, birds), with the exception of fish. Ticks can carry and transmit a remark-able array of pathogens, such as bacteria, spirochetes, rickettsiae, protozoa, viruses, nematodes, and toxins.

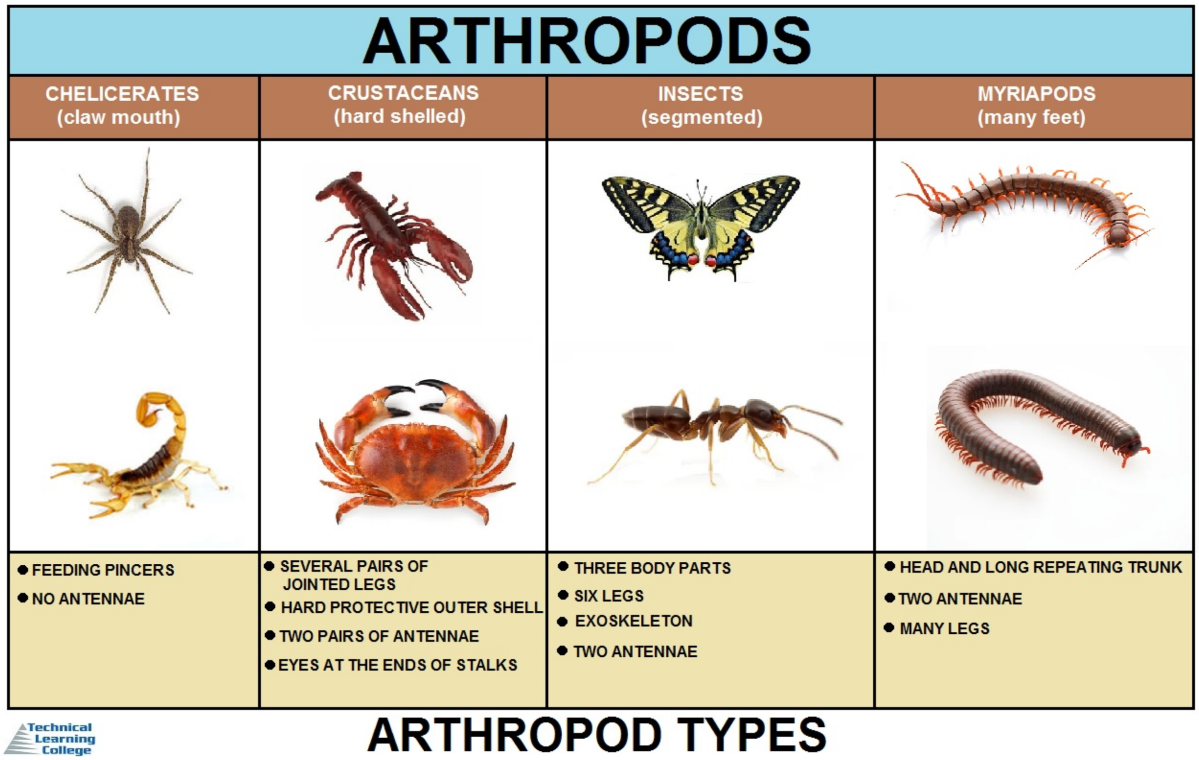


MITE AND TICK BODY REGIONS

Biology of Ticks

Phylum Arthropoda

Animals in the phylum Arthropoda (known as arthropods) share several key characteristics including: a segmented body arranged in two or three groups; paired, segmented appendages; and an exoskeleton made of chitin. Examples of commonly encountered arthropods include crustaceans, spiders, insects, millipedes, and centipedes.



The Arachnida is a class within the phylum Arthropoda. Arachnids include spiders, scorpions, pseudoscorpions, and opiliones or daddy-long legs. The class Arachnida is further divided into smaller groups called orders. The Acari is a name for one of these orders. All mites and ticks belong to this order. Ticks comprise two main groups: hard ticks (family Ixodidae) and soft ticks (family Argasidae).

The identification of medically important species of ticks can be done by local diagnostic facilities at universities or state agencies or with the aid of publications such as Keirans and Litwak (1989), Sonenshine (1979), and the United States Department of Health, Education and Welfare (1967), which provide keys and descriptions. *Ixodes dammini* was first desc-ribed in 1979 and will appear as *Ixodes scapularis* in works prior to this date.

A concise review of tick biology, management, and medical importance was provided by Goddard (1989). A brief understanding of the biology of the tick is important in understanding its role in the various tick-borne diseases and the prevention of these diseases. Ticks are arthropods of the class Arachnida, which includes spiders, scorpions, and mites. Of the 3 families of ticks, only hard ticks (family Ixodidae) and soft ticks (family Argasidae) have medical importance. The principle difference between the 2 groups is the presence of the hard plate, or scutum, that hard ticks possess.

Tick Biology and Behavior Summary

Ticks are essentially mites that have become obligate blood-feeders, requiring a host animal for food and development. Ticks have four stages in their life cycle: egg, the 6-legged larva (seed ticks), and 8-legged nymph and adult (male or female). Larvae and nymphs change to the next stage after digesting a blood meal by molting or shedding the cuticle.

Most of the ticks mentioned in this course have a 3-host life cycle, whereas each of the three active stages feed on a different individual host animal, taking a single blood meal. Larvae feed to repletion on one animal, drop to the ground and molt to a nymph. The nymphs must find and attach to another animal, engorge, drop to ground and molt to an adult. The adult tick feeds on a third animal. A replete or engorged (blood filled) female tick produces a single large batch of eggs and dies. Depending upon the species of tick, egg mass deposited can range roughly from 1,000 to 18,000 eggs.

Life Cycles

The life cycles of hard and soft ticks vary. Most hard ticks undergo a 2-year life cycle in which they begin as 6-legged larvae. *Amblyomma, Dermacentor,* and *Ixodes* are the 3 genera of hard ticks that transmit diseases to humans in the United States. These ticks generally feed for many days, a fact that has some bearing on the treatment of tick bites.

DEER TICK - IXODES SCAPULARIS

The following representative cycle is that of the *Ixodes scapularis* in the northeastern United States. The larvae hatch from eggs in summer and begin seeking hosts in August; these ticks have only 6 legs and are the size of the period at the end of this sentence. If the larvae do not find a host for a blood meal, they die.
The preferred host is the white-footed mouse, *Peromyscus leucopus*. Larvae that successfully feed then fall off the host and live in the soil and decaying vegetation over the winter.

The next spring, most often in May and June, the larvae molt into 8-legged nymphs. These nymphs are quite small and seek their blood meal from a small vertebrate. Humans may be infected as accidental hosts at this point in the cycle. Then, the nymph either dies (if it fails to find a blood meal) or lives in the soil to molt into an adult in the fall season.

The 8-legged adult tick is somewhat larger and seeks a larger host for its required blood meal. The white-tailed deer, *Odocoileus virginianus,* is the preferred host for adult ticks, which mate on deer over the winter months.

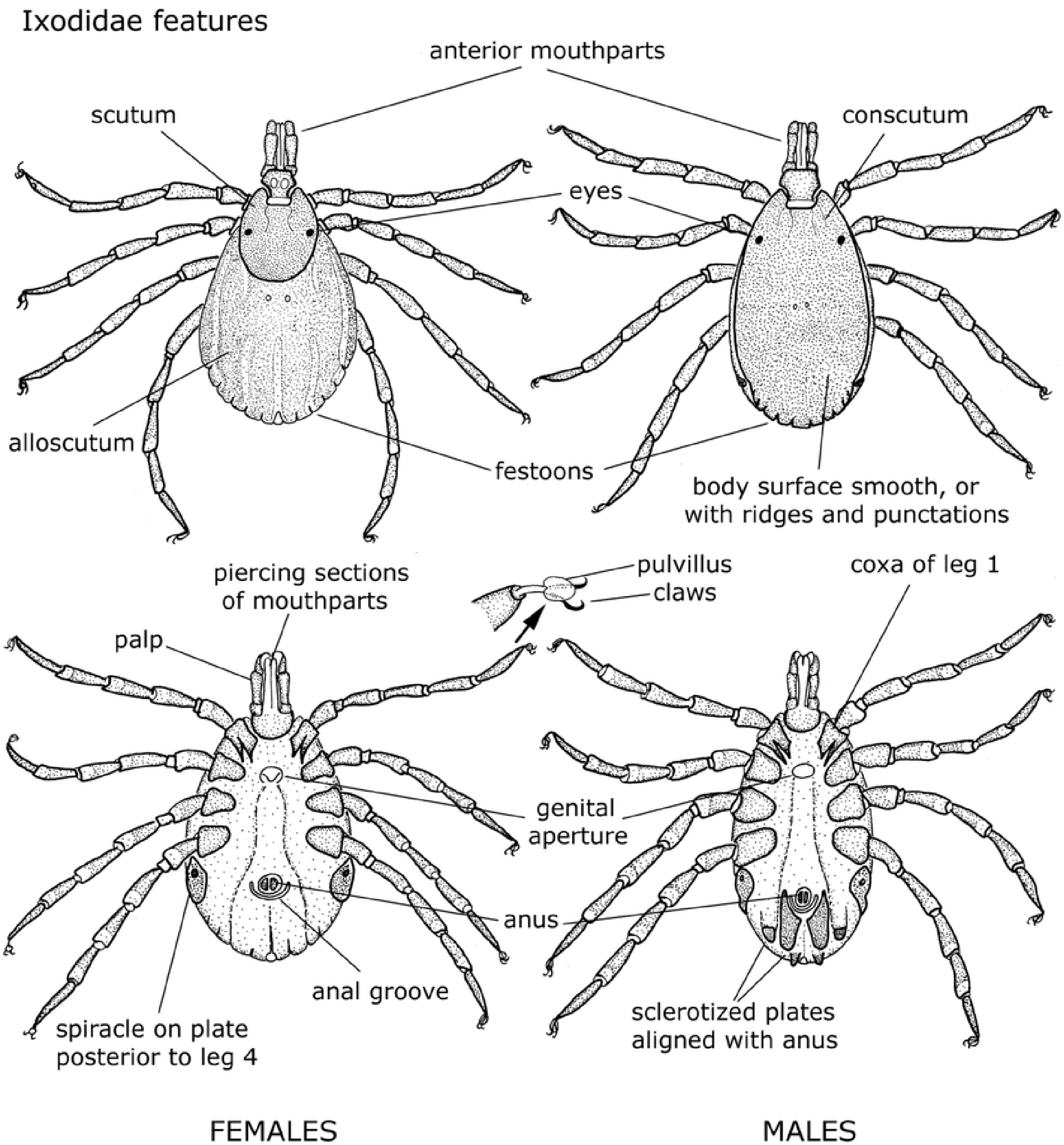
WHITE TAILED DEER

The white-tailed deer is **hard to distinguish from the black-tailed deer. The black-tail has similar antlers** and will sometimes show the characteristic "flag" of the white-tail but usually with less flare. Because the deer plays a key role in the mating of ticks, the increase in the deer population in many parts of the country is an important factor in the epidemic of some tick-borne diseases, such as Lyme disease.

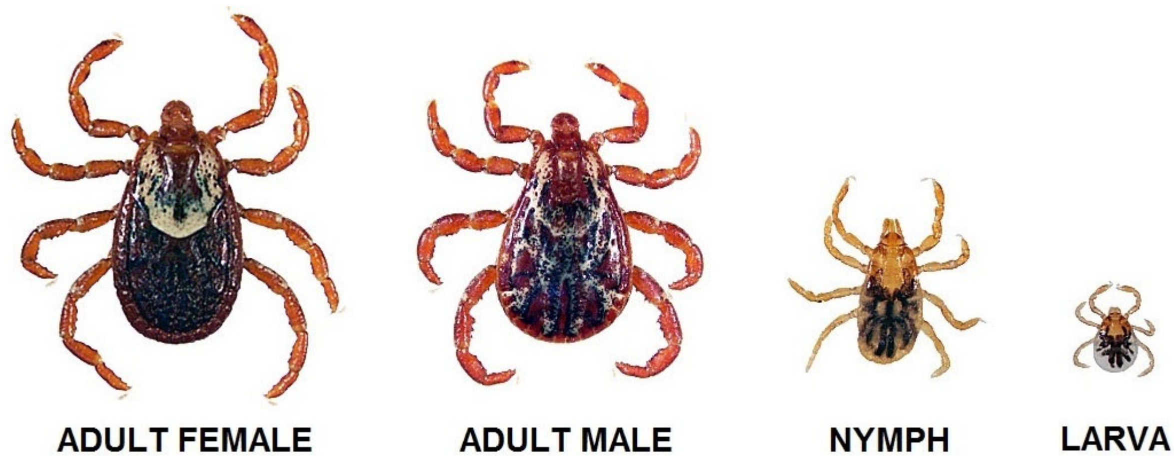
The adult female lays several thousand eggs and then dies. Eggs that survive the winter hatch into larvae the next season, and the 2-year cycle begins anew.

Hard Ticks
General Characteristics and Habits of Hard Ticks (Family *Ixodidae*)

Hard ticks have a scutum while soft ticks do not. In the male hard tick, the scutum is large, completely covering the dorsal surface. In the female, the scutum covers only a part of the dorsal surface and is almost obscured when she becomes engorged.



The capitulum of hard ticks extends forward from the anterior end of the body, bearing some resemblance to a true head, while in soft ticks it is found on the underside and is not usually visible from a dorsal view. The spiracles lie behind the fourth pair of coxae, or basal segments of the leg.



ROCKY MOUNTAIN WOOD TICK
GOOD EXAMPLE OF A HARD TICK

Hard ticks typically take one blood meal in each of the three developmental stages -- larval, nymphal and adult. Both sexes are blood feeders, but only the female becomes greatly distended during engorgement. Most species feed on a different host during each stage, but there are some one-host and two-host species.

Genus *Amblyomma*
Most species of *Amblyomma* have whitish markings, long palpi, a long hypostome, and festoons on the posterior margin of the abdomen. Only eight of the more than 90 described species are found in the United States, *Amblyomma* being more common in the tropics. It is found east of central Texas to the Atlantic Coast and northward to Iowa.

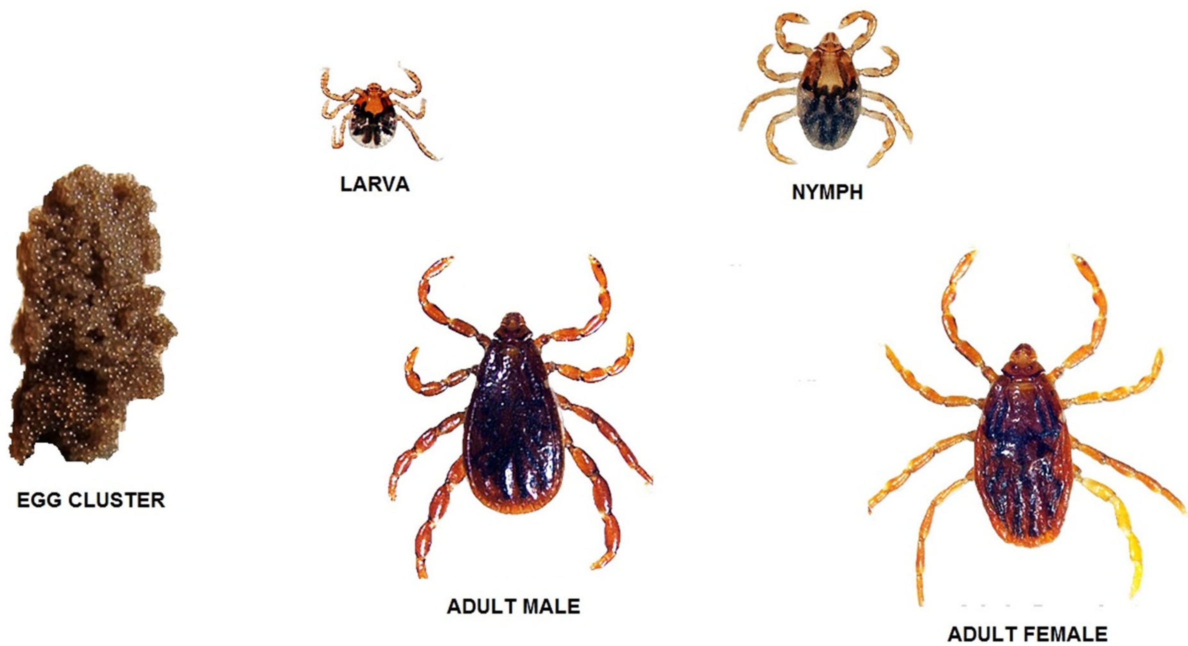
The lone star tick, *Amblyomma americanum*, can carry spotted fever, tularemia, and possibly Q fever. Female specimens are easily recognized by the conspicuous silvery-white spot at the tip of the scutum, hence the name "speck-back" in the Ozark Mountains and the common name "lone star tick" for the Lone Star State of Texas. The pale markings are diffuse on the male specimens. In the southern states east of Texas this species will bite man readily in the larval, nymphal and adult stages. Its bite is quite painful and may itch for a long time. Common hosts are livestock, dogs, deer, birds and man.

The Gulf Coast tick, *Amblyomma maculatum*, is found particularly along the Gulf and South Atlantic coastlines. It has spurs on the second, third and fourth pairs of legs and more diffuse pale markings on the female than does the lone star tick. When present in an area, the ticks often infest the ears of cattle. Screwworm flies are often attracted by the smell of fresh blood in these wounds, laying eggs in them. Later screwworm larvae may feed voraciously, cause festering sores that can kill cattle. Common hosts include livestock, deer, dogs and man.

Genus *Dermacentor*

The genus *Dermacentor* is the most important group of ticks in the United States as pests of man and other animals, both as blood-feeding parasites and as disease vectors. Some species feed regularly on man and other animals; transmit the causative organisms of spotted fever, tularemia, Colorado tick fever, possibly Q fever, and anaplasmosis; and pass many of the causative agents of these diseases transovarially and transstadially.

Specimens of *D. variabilis* and *D. andersoni* are the ticks most frequently involved in cases of tick paralysis in the United States. *Dermacentor* ticks are ornate, with pale markings on the scutum, eleven festoons, eyes, and short palpi. The basis capituli is quadrangular dorsally.



AMERICIAN DOG TICK STAGES DIAGRAM

The American dog tick, *Dermacentor variabilis*, is widely distributed east of the Rocky Mountains and also occurs on the Pacific Coast, and in parts of northern Idaho and eastern Washington. This tick will be discussed in detail as a representative of the hard ticks.

The dog is the preferred host of the adult *D. variabilis*, although it feeds readily on mainly large mammals including man. The adult ticks are commonly found in the spring in their "waiting position" on grass and other low vegetation.

The third pair of legs is used to cling to the grass while the others are waved about ready to grasp any host that comes by. The male remains on the host for an indefinite time, alternately feeding and mating. The female feeds, mates, becomes engorged, and drops off to lay several thousand eggs.

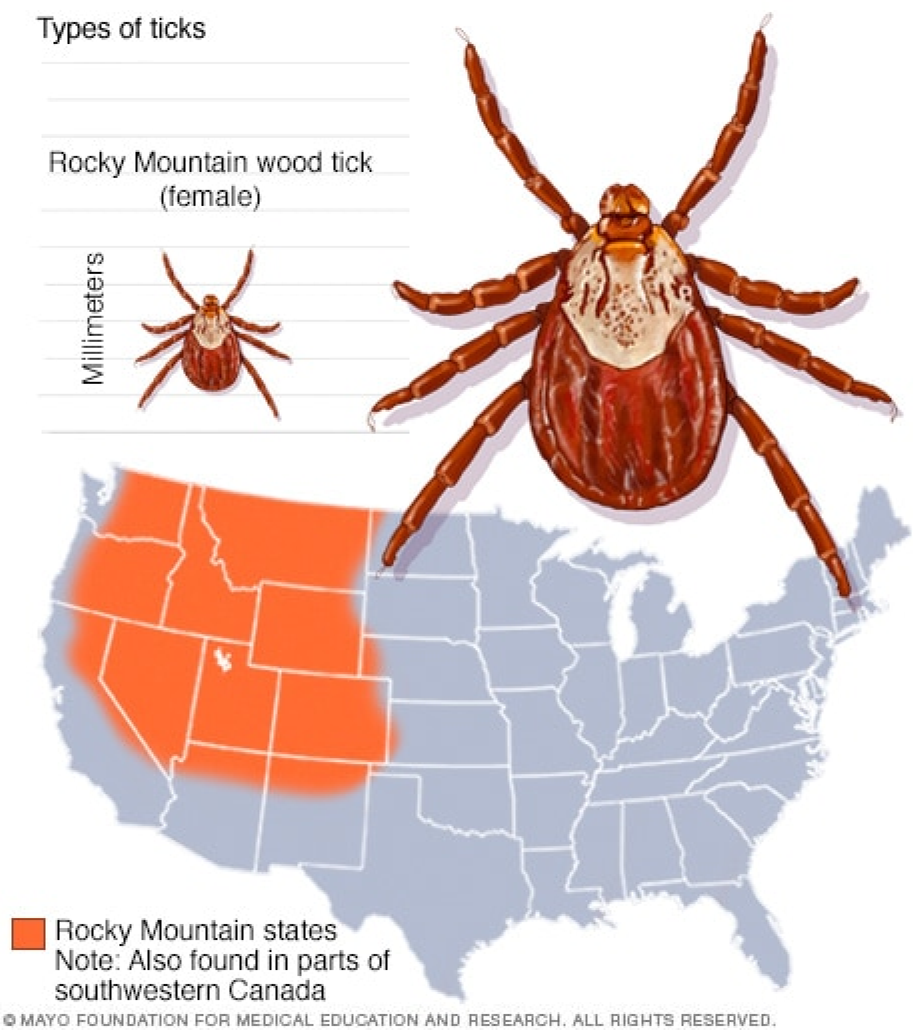
The adult male and females are frequently encountered by sportsmen and people who work outdoors. The males and females have pale whitish or yellowish markings on the scutum. Males may be only 3 mm long, while engorged females may be as much as 13 mm in length.

Larvae seek the host actively and do not assume the waiting position typical of the adults. Meadow mice, white-footed mice, and pine mice are important hosts of larvae.

Males of *D. variabilis* do not feed enough to alter their size noticeably. Females may increase in size from about 5 mm long and 2.5 mm wide to 13 mm long and 10 mm wide, but their engorgement is retarded if males are not present. The newly hatched larvae are about 0.6 mm long, without spiracular plates, and are yellow with red markings near the eyes.

Engorged larvae are about 1.5 mm long and are slate gray to black. Nymphs are similar in appearance to the larvae, but have four pairs of legs and are light yellowish brown with red markings near the eyes. Engorged specimens are slate gray and about 4 mm in length. The entire life cycle is from four months to more than a year.

American dog ticks, as well as other species, are attracted by the scent of animals, hence are most numerous along roads, paths and trails. Engorged ticks that drop from animals using the passageways further increase the concentration at these sites. These facts are important to persons applying pesticides for tick control.



The Rocky Mountain wood tick, *Dermacentor andersoni*, is found in the Rocky Mountain States and in southwestern Canada. The life cycle of this three-host tick is two to three years. The larvae and nymphs attack small mammals, and the adults obtain their blood meals from large mammals including man. The range of this tick coincides with the area in which cases of Colorado tick fever are contracted. It is similar to the American dog tick, but adults of the wood tick in general have more pale coloring and larger goblets on the spiracular plates than the American dog tick.

The winter tick, *Dermacentor albipictus*, is widely distributed throughout North America. It is a one-host species parasitic on cattle, horses, moose, elk, deer and sometimes man. These ticks may be extremely numerous on these large animals and may cause blood loss leading to anemia and even death. The spiracular plates are oval with very large goblets.

The Pacific Coast tick, *Dermacentor occidentalis*, is a three-host tick whose life cycle on small rodents and large mammals may be completed in less than three months. It is a serious year-round pest of cattle and will attack man. It is a known vector of tularemia and a suspected vector of Rocky Mountain spotted fever. The basis capituli has conspicuous tooth-like dorsal projections on the posterior margin known as cornua.

Genus *Ixodes*
Ticks in the genus *Ixodes* are easily recognized by the position of the anal groove, which lies in front of the anus and extends from one side of the body to the other. There are 34 species of ticks in the genus Ixodes in the United States, more than in any other genus. Male specimens have a complicated arrangement of plates on the ventral side of the abdomen. Most species have enlarged club-like palps.

The black-legged tick, *Ixodes scapularis*, occurs in the eastern half of the United States. Male and female specimens are frequently found mating on deer, dogs and other large mammals in the fall and winter. This species will also feed on man and birds.

Western black-legged tick *Ixodes pacificus* | Pacific Coast Tick *Dermacentor occidentalis* | American Dog Tick *Dermacentor variabilis*

The Pacific tick, *Ixodes pacificus*, is the western counterpart of *I. scapularis*, and both species are related to the castor-bean tick of the Old World, *Ixodes pacificus*. *Ixodes pacificus* adults will bite deer, cattle and man readily.

Genus *Rhipicephalus*

Many species of ticks in the genus *Rhipicephalus* occur in Africa and Asia where they are important vectors of disease to man and animals. These ticks have a hexagonal basis capituli, eyes on the scutum and festoons on the posterior margin of the abdomen. Male specimens are distinguished from most other common ticks by the adanal plates and accessory plates on either side of the anus.

The brown dog tick, *Rhipicephalus sanguineus*, is found in most of the United States. It is a reddish-brown species that attacks dogs and other mammals but rarely man. It is not known to transmit human diseases in the United States, although it is a known vector of Marseilles fever in the Mediterranean region.

The ticks are frequently found attached to the ears and in between the toes of dogs. This species is one of the most common in homes, where it feeds on dogs and then drops off the infested animal. The engorged female specimens, sometimes about a 13 mm long, are particularly noticeable as they crawl on walls or around baseboards and cracks, looking for protected areas in which to deposit 1,000 to 3,000 eggs.

The life cycle of this species can be completed in less than two months. In the southern United States this species occurs in buildings, kennels and small animal hospitals, and outdoors in yards. In the North, this tick is rarely found outdoors. It is a very difficult and important species to control.

This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

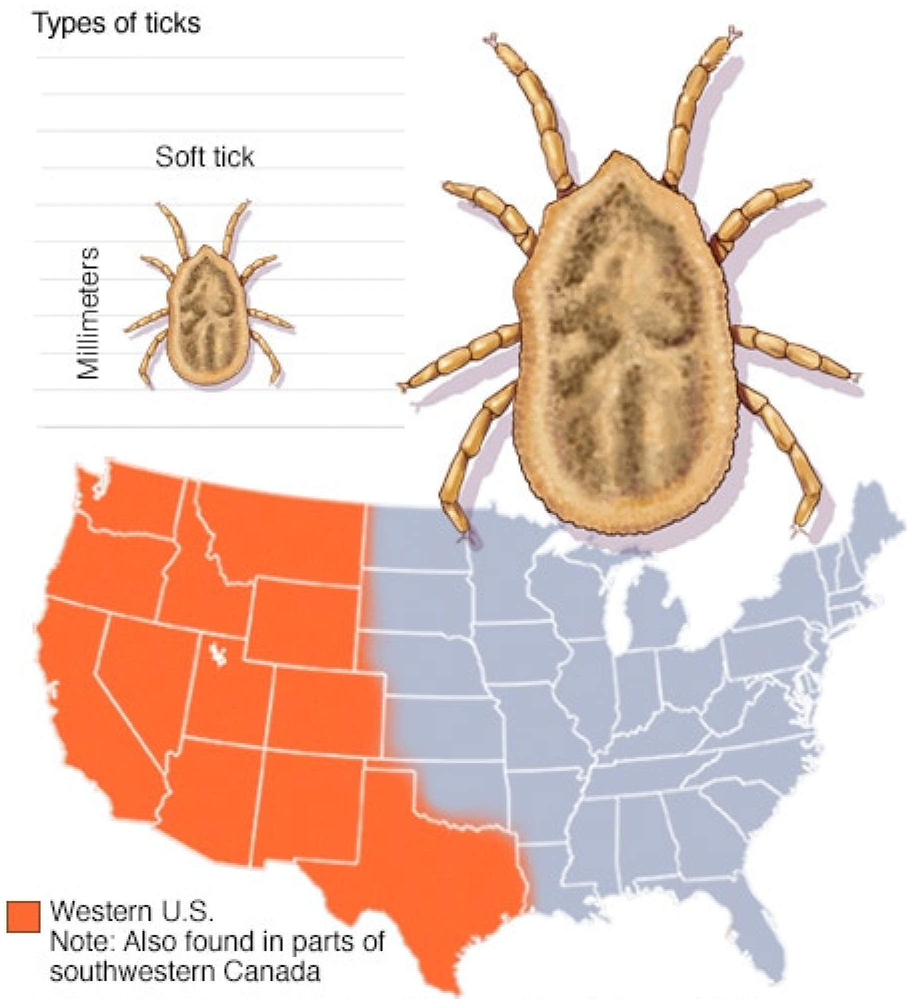
2017 Changes to EPA's Farm Worker Protection Standard

In late 2015 the Environmental Protection Agency issued the long awaited revision to the Worker Protection Standard (WPS). This law it is now technically active and it will be enforced. Please keep in mind that the WPS covers both restricted use AND general use pesticides. This course is not for worker and/or handler training. Always follow the label and your State Pesticide Agency rules.

This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

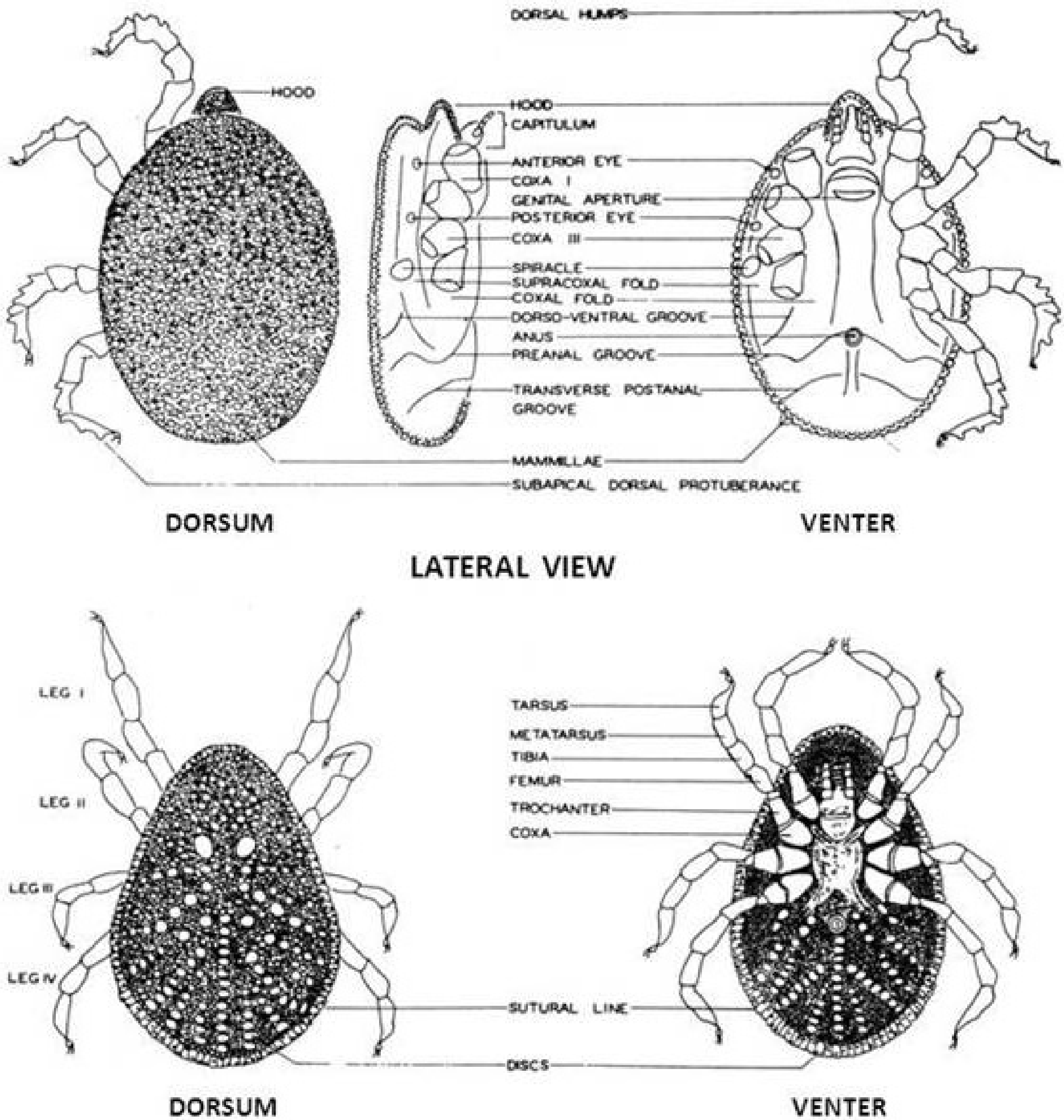
Soft Ticks
General Characteristics and Habits - Soft Ticks (Family *Argasidae*)

Male and female soft ticks are similar in appearance, with no dorsal plate (scutum) to distinguish the sexes as in hard ticks. The capitulum which bears the mouth parts is located beneath the anterior margin of the body. The spiracles or respiratory openings lie on the sides of the body above the third and fourth pairs of legs.



Although some species of soft ticks feed on humans, they are more common on birds and occasionally are found on bats and other small mammals. The sexes can be distinguished by the shape of the genital opening which in males is circular or crescent-shaped and in females is a transverse split, wider than long.

HYPOTHETICAL SOFT TICKS WITH KEY CHARACTERS LABELED



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Genus Ornithodoros
Ornithodoros is the most important of the four genera of soft ticks. The ticks in this genus have a more globular body without the sutural line found in the various species of Argas. The body is roughened or warty in appearance with tiny protuberances, called "mammillae."

The hypostome has well-developed teeth. Several species are known in the United States, including Alaska and Hawaii, of which four are known vectors of relapsing fever in the United States.

The relapsing fever ticks, *Ornithodoros* species, are seldom seen by the average person since they are primarily "nest ticks" which can survive starvation for months or even years. Human beings are occasionally bitten by these hungry ticks and contract cases of relapsing fever in mountain cabins, in caves, or near wild animal burrows.

For example, *O. hermsi* is found at high elevations in the West, particularly Idaho, Oregon, Washington, California, Nevada, and Colorado, where it parasitizes small mammals such as the western chipmunk (*Eutamias*) or tree squirrels (*Tamiasciurus*).

ORNITHODOROS PARKERI

Occasionally, people sleeping in mountain cabins come in contact with infected ticks and contract relapsing fever. *Ornithodoros parkeri* is a large species which attacks man and rodents and is found in nine western states. It is an efficient vector of relapsing fever and can transmit Rocky Mountain spotted fever.

Ornithodoros Turicata, also a large tick, is found in the southern and western United States. It is found in caves, holes made by burrowing animals and at campsites.

Its hosts include rodents, snakes, terrapins and various domestic animals, as well as man. Even after long starvation, it is an efficient vector of relapsing fever. Both *O. Turicata* and *O. parkeri* transmit the spirochete of this disease to their offspring as far as the fourth generation. *Ornithodoros talaje* occurs in southern United States.

ORNITHODOROS ERRATICUS

Typical Ticks of Domestic Animals

Amblyomma and Rhipicephalus ixodid ticks
Amblyomma species are widespread on domestic animals throughout tropical and sub-tropical regions. Typical Amblyomma species are: Amblyomma americanum, the lone-star tick of southern and eastern USA; Am. cajennense, the Cayenne tick of South America and southern USA; Am. variegatum, the bont tick of Africa and the Caribbean. A typical Rhipicephalus species is Rhipicephalus sanguineus, the tropical dog tick, specialized to feed only on dogs. It is distributed globally throughout the warm countries, wherever humans with their dogs live.

CAYENNE TICK DIAGRAM

Typical Rhipicephalus species that feed on cattle in Africa are R. appendiculatus, the brown ear-tick, and R. evertsi evertsi, the red-legged tick. Rhipicephalus (Boophilus) microplus is the most important tick of cattle in many tropical and sub-tropical countries to where it spread from Southeast Asia on transported cattle.

Three-host Life-Cycle of Amblyomma and many Rhipicephalus species
Following one individual tick: the eggs laid on the ground hatch and the larvae wait for or actively seek a host (questing behavior). The larva feeds, detaches from its host, molts into a nymph when on the ground and quests by crawling on the ground or waiting on vegetation. The nymph feeds and repeats the same process as the larva but will emerge having developed the anatomy of either an adult female or male.

Adults quest similarly to nymphs. Most hard ticks have a three-host life-cycle. The female attaches only to a species of host that it is adapted to for reproduction. The female engorges on much blood, expanding greatly, then detaches and converts the blood meal into eggs which are laid on the ground. Females of large species of Amblyomma engorge to a weight of 5g and lay 20,000 eggs. The female dies after this single egg-laying.

The male will take repeated small meals of blood and attempt to mate repeatedly whilst on the same host. Feeding times range over: larvae 4–7 days, nymphs 5–10 days, adults 8 to 20 days. The time spent molting and questing off the host can occupy the remainder of 6 to 18 months for a single tick to complete its life cycle.

The life-cycle timing is often expanded by diapause (= cease development or activity) in adaptation to seasonal variation of moisture and heat. Ticks are highly adapted for long term survival off the host without feeding and can extract moisture directly from humid air. However, survival is greatly reduced by excess heat, dryness and lack of suitable hosts to attach to. Survival on the host is also greatly reduced by grooming and by hypersensitive immune reactions in the skin against the feeding of the ticks.

Boophilid ticks, a sub-genus within Rhipicephalus
These ticks, commonly known as cattle ticks or blue ticks, have a highly characteristic morphology and one-host life-cycle. They are economically important to cattle rearing industry by causing direct parasitic losses and by transmission of microbes. In addition to Rhipicephalus microplus, species of most importance to domestic animals are R. annulatus which is widespread in tropical and sub-tropical countries and R. decoloratus which occurs in Africa.

BOOPHILID TICK EXAMPLE

One-host life-cycle of Rhipicephalus microplus
These ticks are adapted to the advantages of specializing to feed on cattle and with all the feeding stages occurring on one individual host in a rapid sequence. They also can survive by feeding on deer or some wild bovid hosts. Infestation starts when larvae on vegetation attach to a new host. When a larva feeds it molts at the site where it feeds and emerges as a nymph. The nymph feeds at the same site or close by and molts where it feeds.

It emerges from molt as either an adult female or male. The female's single large blood meal is converted into a batch of 2000 eggs. The males take several small meals of blood to support their repeated attempts at mating. The molts are rapid and the next stage remains in the hair coat to start feeding again. The combined feeding and molting periods take approximately 21 days. The engorged female drops from the host, hides under litter on soil surface, lays one batch of eggs then dies. When eggs hatch the larvae crawl up grass stems and wait until they can attach to passing cattle.

Hyalomma Ticks

This genus contains many species of hard ticks important to domestic animals in hot dry regions in Africa, the Mediterranean basin, Middle East, Pakistan, India and through to China. Typical species are Hyalomma anatolicum, Hy. marginatum rufipes, Hy. truncatum and Hy. detritum, which feed as adults on cattle, sheep and goats. Hyalomma dromedarii is specialized to feed on dromedary camels. Hyalomma ticks are adapted to live in regions with large seasonal variation of temperature and low rainfall. Diapause is an important mechanism to adjust to these climates. Another adaptation is to have a life-cycle within one species that can be two-host or three-host.

HYALOMMA TICK EXAMPLE

For example: Hy. a. anatolicum may feed on a hare, molt on the hare and feed again on the same individual hare, detach and molt to an adult and then feed on a cow; this is a two-host life-cycle. Or it may feed as a larva on a gerbil, then as a nymph on a cow and then as an adult on another cow in a three-host life-cycle. Furthermore, this tick commonly feeds as a three-host tick with larvae, nymphs and adults feeding on separate individual dairy cows confined to cattle housing in zero-grazing systems.

Argas and Ornithodoros Soft Ticks
Argas persicus, the fowl tick, is a major pest of poultry birds. The tampan ticks within Ornithodoros moubata complex of species infest domestic pigs and also feed on humans. Ornithodoros savignyi is often found in large numbers at enclosures where camels and cattle are herded.

Multi-host life-cycle of Ornithodoros moubata
Argasidae soft ticks have different life cycles from Ixodidae hard ticks, and these are very variable between species. Typically, in Ornithodoros, a larva hatches from an egg laid in the nest or resting place of the host. The larva does not feed but directly molts into the first nymph stage. This feeds then molts into the next nymph stage.

Feeding by soft ticks is generally completed within minutes rather than days as with hard ticks. Depending on circumstances, there will be four or five nymph stages, progressively larger.

Finally, a molt produces an adult female or male. The female takes repeated blood meals that are small compared to a female hard tick. Each blood meal is converted to a small batch of eggs. The male feeds sufficiently to support its mating. The life-cycle of Argas persicus is similar, but the larva feeds on blood of its bird host, remaining attached for approximately 7 days.

ORNITHODOROS MOUBATA EXAMPLE

Other Groups of Ticks

Other genera with species that are often of high local importance to domestic animals include the following as a few examples.

Ixodes (Ixodes ricinus, the deer tick of Europe; Ixodes scapularis, the black legged tick of North America; Ixodes holocyclus, the paralysis tick of Australia). Haemaphysalis (Ha. leachii, the yellow dog tick of the tropics).

Dermacentor (Dermacentor andersoni, the Rocky Mountain wood tick; Dermacentor variabilis, the American dog tick; D. reticulatus, the ornate dog tick of Europe).

Dermacentor nitens the tropical horse tick of the Americas has a one-host life-cycle similar to the boophilids. Margaropus winthemi, the beady legged tick infests horses and cattle in South Africa. The soft tick Otobius megnini, the spinose ear tick, has its nymphs feeding within the ear canal of many species of domestic animals. Adult Ot. megnini do not feed. This tick occurs in the Americas and has spread to Africa and Asia.

Small Mammals and Birds
Rodents and birds can infect ticks with *B. burgdorferi* and transport ticks onto your property. The importance of these animals in the dynamics of Lyme disease depends on the abundance of the animal host, number of ticks feeding on the host, and the host's ability to infect feeding ticks with the Lyme disease spirochete (i.e., the reservoir potential). In other words, what animals are contributing infected ticks to your property? Some animals may have a lot of ticks, but not be able to infect them with spirochetes.

Rodents
While different rodent and bird species may predominate in certain years and locations, white-footed mice, *Peromyscus leucopus*, are generally the most abundant and efficient animal reservoir for the Lyme disease bacteria. They contribute more infected ticks than eastern chipmunks or meadow voles.

White-footed mice also are a reservoir for the causal agents of ehrlichiosis and babesisois. Over 90% of white-footed mice will be infected with *B. burgdorferi* in many areas and up to half have been found to carry all three pathogens in some areas. In one study, a single mouse was estimated to infect as many ticks as 12 chipmunks or 221 voles. Meadow voles, *Microtus pennsylvanicus*, are most abundant in fields, pastures, orchards, which harbor few *I. scapularis*.

Although they harbor fewer ticks, short-tailed shrews, *Blarina brevicauda*, with their high reservoir potential, may contribute to the maintenance of both *B. burgdorferi* and *B. microti* in some areas, especially when mouse numbers are low. By contrast, squirrels have a lower Lyme disease reservoir potential. One study indicated that squirrels might reduce or dilute the number of infected ticks in the landscape.

White-footed Mouse
***Peromyscus leucopus* (Rafinesque)**
The white-footed mouse is the principal animal carrying the pathogens that cause Lyme disease, human anaplasmosis (i.e., ehrlichiosis) and human babesisois. White-footed mice are found throughout most eastern and Midwestern United States, except in Florida and northern Maine. This mouse is difficult to distinguish from the deer mouse, *P. maniculatus*.

White-footed mice have a home range of generally 0.1 to 0.5 acre, sometimes larger. This woodland and brushy area dwelling animal nests in stonewalls, tree cavities, abandoned bird or squirrel nests, under stumps, logs, and may readily enter and nest in buildings, especially during the winter months. Mice may line the nest with fur, feathers or shredded cloth. These nocturnal animals aromnivorous and feed on acorns, seeds (including newly planted gardens), fruits, insects, snails, tender young plants, and carrion.

Mouse densities usually are around 1-10 per acre but can be higher (15 per acre) and may go relatively unnoticed until they enter homes that are not rodent proof. Breeding spring through fall, a female mouse typically has 3-4 young after a gestation period of 22-25 days. The mice reach sexual maturity in 6-7 weeks. There are no ticks on the mice during the winter and, inside buildings, they do not pose a risk for the transmission of Lyme disease. Folded hardware cloth (1/4-inch mesh) may be used to exclude mice from buildings, flowerbeds, and garden plots. Cleaning up small black droppings and urine-contaminated areas in confined areas can pose a risk for hantavirus disease.

Reduction of small mammal abundance should focus mainly on reducing mouse habitat near homes and encouraging predators like foxes, snakes, hawks, and owls, and weasels, to name a few. However, predators require large territories of several square miles. Although not quantified, this author has noticed mouse populations drop dramatically (based on trapping success) with resultant drops in the tick population at sample sites where a fox family or snakes have taken up residence in or near the stone walls. Mice have relatively small home ranges. Dense vegetation and ground cover plants like pachysandra adjacent to homes provide cover for rodents as they forage for food. Shaded stonewalls overgrown with grass and brush can harbor many mice and chipmunks.

Eastern Chipmunk
Tamias striatus L.
Eastern chipmunks are found in most states east of the Mississippi River, except along the southeastern coastal region. They are often the second most important rodent in the maintenance of Lyme disease and can be the principal reservoir in some areas. Solitary by habit and active during the day, chipmunks feed on seeds, grains, fruits, nuts, bulbs, mushrooms, insects, carrion and may prey on young birds and eggs. They can climb trees to gather seeds, fruit and nuts and store food throughout the year. They hibernate during the winter, but may become active for brief periods on sunny warm days. Requiring ample vegetative cover, chipmunks are found in deciduous woodlands with undergrowth, old logs, stonewalls, and in brushlands. Their home range is small, typically less than 100 yards in diameter and females defend a 50-yard radius around the home. A small (2 inch), inconspicuous entrance leads to a complex burrow system. There are typically 2 to 4 chipmunks per acre, but densities may be higher with adequate food and cover. There are 1 or 2 litters each year. Hardware cloth (1/4-inch mesh) may be used to exclude chipmunks from buildings and flowerbeds.

Birds

Birds are frequent hosts for immature stages of the blacklegged tick. At a woodland residence, 26% of birds were infested with ticks and 94% were *I. scapularis*. While some bird species can infect feeding ticks with *B. burgdorferi* (i.e., American robin, veery, grackle, common yellowthroat, Carolina wren, house wren), other species (i.e., gray catbird, woodthrush) do not. Due to variability in bird species composition, population, habitat preferences, reservoir competence and feeder activity, it is unclear how many ticks (much less those infected with spirochetes) most birds actually contribute to a typical residential landscape. One early study found that American robins, a reservoir competent bird, were likely contributors to the nymphal tick population found in some suburban residential landscapes.

Unlike mice, however, reservoir competency in robins declines after 2 months. A recent study suggested most birds probably contribute few infected ticks and may actually dilute pathogen transmission, at least in comparison to mice. Bird feeders in landscaped areas like mowed lawns were not found to be a risk factor for Lyme disease, probably because the habitat does not favor tick survival and seed feeding birds that frequent feeders in the summer do not deposit many ticks. However, higher tick abundance has been noted where feeders were installed at or beyond the lawn edge in wooded habitat suitable for tick survival and rodent activity (Gary Maupin, CDC retired, personal observation). Adult ticks, which are active in the fall, winter and spring months, do not feed on birds.

It is unknown what impact summer or winter fruit bearing trees and shrubs for birds has on the prevalence of ticks as related to mouse and chipmunk activity, as seeds and fruits can also serve as a food source for these animals.

Many berry plants, however, are important to fall migrants and the berries are quickly consumed. Deer resistant bird favorites include bayberry (*Myrica pensylvanica*) and Virginia creeper (*Parthenocissus*) and highbush blueberry (*Vaccinium corymbosum* – produces summer berries); cedars and certain holly cultivars, however, are subject to heavy deer browsing. Common winterberry (*Ilex verticillata*) is also fairly susceptible to heavy deer browse damage. It requires both female and male plants to produce winterberries for birds. Native viburnums will suffer only occasional to minimal damage from deer and are good bird plants. Japanese barberry (*Berberis thunbergii*) is considered invasive.

Possible small animal and bird management strategies include:

- Keep potential mouse nesting sites in stonewalls and woodpiles near the residence free of brush, high grass, weeds, and leaf litter.
- Seal or rework stonewalls near or under the home to reduce harborage.
- Move firewood away from the house.
- Place the birdhouses and feeders away from the house, but it is unknown if this will decrease risk of exposure to ticks. Clean up spilled feed (spilled bird feed can also attract mice).
- Set up bird feeders in late fall and winter when natural foods are scarce (and the immature stages of *I. scapularis* are not present on birds).
- Seal foundations. For example a garden shed on cement blocks can harbor raccoons, skunks, or woodchucks. This can be avoided through a proper foundation or use of hardware cloth buried at least two feet beneath the ground. A poorly sealed building or old garden shed can harbor mice.

Host-Targeted Chemical Tick Control for Rodents

The first rodent-targeted product was a cardboard tube of cottonballs treated with the insecticide permethrin (Damminix®). The product is aimed at larvae and nymphs of *I. scapularis* feeding on white-footed mice. The effectiveness of this product is dependent upon the mice collecting the cotton as nesting material from cardboard tubes distributed throughout the mouse habitat. Studies in Connecticut and New York state failed to show any reduction in the number of infected, host-seeking *I. scapularis* nymphs when this product was used for a three-year period in woodland and residential areas of about 4 acres or less. Lack of control may be due to failure by the mice in some areas to collect the cotton or the presence of alternative tick hosts, such as chipmunks, an important secondary tick host and spirochete reservoir. Reductions in tick numbers were reported in a Massachusetts study with the treatment of one 18-acre tract.

Another approach, using bait boxes for the topical treatment of rodents with fipronil, was first evaluated for the control of *I. scapularis* on wild white-footed mice on an island community in Connecticut and then subsequently at residential locations in Connecticut, New Jersey, New York and Massachusetts. Fipronil is the active ingredient in topical or spray flea and tick control products (Frontline®). In the laboratory, a single topical application to a mouse can kill all ticks on the animal for up to 7 weeks. In the island community trial, the prevalence of infection of *B. burgdorferi* in the mice dropped dramatically after one year and nymphal tick populations were substantially reduced after only two years of use.

A commercial version called the Maxforce Tick Management System (Bayer Environmental Science, Montvale, NJ) received EPA registration July 2003 and is available through licensed pesticide applicators. The rodent bait box is one alternative to area applied sprays or efforts to reduce the small mammal population. The device consists of a sealed, ready to use, child resistant box containing nontoxic food blocks and an applicator wick impregnated with 0.70% fipronil. This device treats both white-footed mice and Eastern chipmunks as they pass through the box to forage on the food attractant. While high levels of immature tick control may be obtained by treating single, isolated properties, a number of adjacent homeowners may have to use this approach for optimum impact. The impact of the boxes on the tick population accumulates over time. There is no effect on the existing host-seeking tick population the first year the boxes are placed, so a pesticide application may be a consideration in the initial year if the Maxforce Tick Management System is used.

Prevention of Tick-Associated Disease in Companion Animals

The prevention of Lyme disease and other tick-associated disease in dogs relies on avoiding tick habitat, reducing ticks on the animal, daily tick checks, and use of one of the canine Lyme disease vaccines available (whole-cell killed bacterin or recombinant outer surface protein A of *B. burgdorferi* - OspA). Electronic fencing systems can help confine a pet in an area where the animal is less likely to pick up ticks or where other tick control measures have been implemented. If the pet is not allowed to freely roam into the wooded areas, it is less likely to pick up ticks. Animals can carry ticks into the home.

However, studies to determine whether pet owners may be at increased risk of Lyme disease have been inconclusive. Ticks, once attached or fed, will not seek another host. Dogs and cats should be checked daily for ticks, but the immature stages may be virtually impossible to detect on longhair or dark-hair animals. Outdoor activities with animals also may increase the exposure of pet owners to ticks and their habitat.

A veterinarian should be consulted about the prevention and treatment of Lyme disease in your animals. A variety of products crepel and/or kill ticks on the animal. Some are available over the counter (OTC) and others only through your veterinarian. Chemical products to protect dogs from ticks are available as spot-ons, sprays, collars, powders, and dips. Ingredients include several insecticides such as pyrethrin, permethrin, amitraz, or fipronil (see section on chemical control). Some products are combined with an insect growth regulator to help control flea eggs. Follow label directions to minimize the chances for an adverse reaction to the product in your pet and do not combine products without the advice of your veterinarian. Different products can contain the same or similar ingredients, which could result in an overdose of the animal.

Although the risk of clinical disease is low, the canine Lyme vaccines can provide high levels of protection for dogs living in or traveling to Lyme disease endemic areas with a likely exposure to ticks. Depending upon the vaccine, an initial dose can be given as early as 9 or 12 weeks of age with a second required dose several weeks later. An annual booster is recommended.

Backyard Wildlife Programs and Environmentally Friendly Lawns

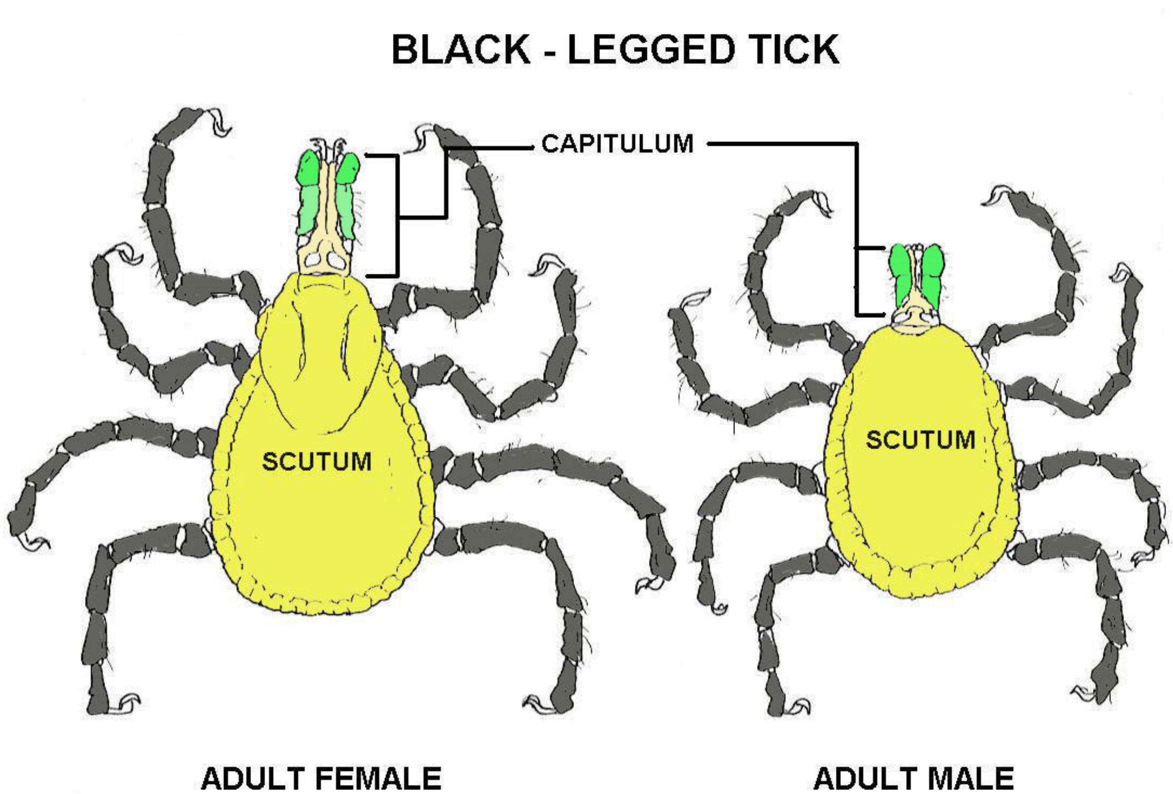
With increased environmental awareness, the focus for some residents has been to provide a more natural or organic landscape, with reduced inputs of energy, water, pesticides, fertilizer and labor, and provide increased wildlife habitat. Some shrubs and other plants are selected for their wildlife value due to the berries, fruit and cover they provide for birds and small mammals. Many resources are available to help create backyard wildlife habitats. How can the desire to have a more natural, environmentally friendly habitat be balanced with the need to reduce contact with animals carrying ticks and the creation of a tick safe zone? The presence of deer and rodents will result in the presence of ticks. Little information is available on how to integrate these two different objectives.

Open lawns harbor fewer ticks and wildlife that carry potentially infected ticks. There is some evidence that increased animal diversity can actually reduce the rate of transmission of tick-associated disease, resulting in fewer infected ticks, although ticks are still present. The fragmented woodland and ecotone environment of suburbia favors the deer, mice, and chipmunks most involved in the maintenance and transmission of ticks and tick-associated diseases. Mixed ecotone with uncut grass, wildflower and shrubby vegetation, especially adjacent to woodlands is good deer, mouse and tick habitat.

Little is known about relative tick densities in various alternative landscapes to turf like wildflower meadows, gardens, and butterfly gardens. It is not known what specific plants or plant groupings may be associated with more or fewer ticks or if it makes that much of a difference. Some plants used in butterfly gardens are attractive to deer, while most herbs are highly resistant to deer browsing. Fencing against deer will allow greater landscape flexibility. While data is limited, meadows appear to harbor few blacklegged ticks except along the edge with woodlands, dense vegetation and stonewall. If a property is large enough, a separate wildlife and tick-managed zone could possibly be maintained. The objective of a tick management program is to discourage activity of several key tick hosts and create a physical and/or chemical barrier between woodland habitat and areas the family uses most frequently.

Introduction Tick-borne Diseases

A single tick bite can transmit multiple pathogens, a phenomenon that has led to atypical presentations of some classic tick-borne diseases. In the US, ticks are the most common vectors of vector-borne diseases. In North America, the following diseases are caused by tick bites: Lyme disease, human granulocytic and monocytic ehrlichiosis, babesiosis, relapsing fever, Rocky Mountain spotted fever, Colorado tick fever, tularemia, Q fever, and tick paralysis. In Europe, the list is similar, but other diseases should be considered, as well; these include boutonneuse fever (caused by a less virulent spotted fever rickettsial organism), and tick-borne encephalitis. Secondary infections and allergic reactions to proteins in tick saliva are also possible.



For each species of tick, the geographic distribution, habitat, hosts, life cycle, seasonal abundance, responses to environmental factors, as well as direct and indirect medical effects are described. Information concerning the removal of ticks, outbreaks of tick-borne diseases, and natural enemies are presented. Tick management approaches including methods of population monitoring, decision-making, and intervention are described. All of these tick species are attracted to carbon dioxide and generally prefer low light intensity, high relative humidity, and protection from constant breezes. Temperature and humidity are the two most important environmental factors affecting survival.

Ticks are highly sensitive to carbon dioxide, exhaled by animals as they breathe, and seek it out. Ticks will travel up the stems of grasses and low shrubs to wait for a passing mammal to brush against them.

The ticks will then cling to the new host and attach itself by secreting a cement-like substance around its mouthparts and insert it into the host. If the tick has not found a host by the time that hot summer temperatures arrive, it seeks cover under leaves and remains dormant until the next year. Peak periods of tick activity can begin as early as March during warm seasons. They usually subside by mid-July.

How Ticks find their Hosts
Ticks can feed on mammals, birds, reptiles, and amphibians. Most ticks prefer to have a different host animal at each stage of their life.

Ticks find their hosts by detecting animals´ breath and body odors, or by sensing body heat, moisture, and vibrations. Some species can even recognize a shadow. In addition, ticks pick a place to wait by identifying well-used paths. Then they wait for a host, resting on the tips of grasses and shrubs. Ticks can't fly or jump, but many tick species wait in a position known as "questing".

While questing, ticks hold onto leaves and grass by their third and fourth pair of legs. They hold the first pair of legs outstretched, waiting to climb on to the host. When a host brushes the spot where a tick is waiting, it quickly climbs aboard. Some ticks will attach quickly and others will wander, looking for places like the ear, or other areas where the skin is thinner.

How Ticks Spread Disease
Ticks transmit pathogens that cause disease through the process of feeding.

- ✓ Depending on the tick species and its stage of life, preparing to feed can take from 10 minutes to 2 hours. When the tick finds a feeding spot, it grasps the skin and cuts into the surface.
- ✓ The tick then inserts its feeding tube. Many species also secrete a cement-like substance that keeps them firmly attached during the meal. The feeding tube can have barbs which help keep the tick in place.
- ✓ Ticks also can secrete small amounts of saliva with anesthetic properties so that the animal or person can't feel that the tick has attached itself. If the tick is in a sheltered spot, it can go unnoticed.
- ✓ A tick will suck the blood slowly for several days. If the host animal has a bloodborne infection, the tick will ingest the pathogens with the blood.
- ✓ Small amounts of saliva from the tick may also enter the skin of the host animal during the feeding process. If the tick contains a pathogen, the organism may be transmitted to the host animal in this way.
- ✓ After feeding, most ticks will drop off and prepare for the next life stage. At its next feeding, it can then transmit an acquired disease to the new host.

What can be done to Control Tick Populations?
There are measures you can take to reduce the number of ticks around your home. In general, drier conditions mean fewer blacklegged ticks:

- ✓ Keep lawns mowed, brush trimmed, and leaf litter away from the home.
- ✓ Keep trails or paths in wooded areas on your property clear of vegetation.

Precautions to Minimize Tick Bites:
When walking in tick-infested areas during the spring and summer months, take the following precautions:

1. Wear protective, light-colored clothing, such as long pants tucked into socks and long sleeved shirts buttoned at the neck and sleeves.

2. Apply an arthropod repellent containing DEET to exposed flesh and to shirt collars, shirt cuffs, beltline, and trouser cuffs.
3. Ask your veterinarian for advice on effective tick repellents for your pets.
4. Check both yourself and your pets for ticks on a regular basis, at least twice per day and remove ticks as soon as found.

However, the following precautions are encouraged:
1. On children, do not use high concentration formulations (above 30 percent).
2. Apply the repellent to clothing, rather than to skin.
3. Do not apply DEET to hands or other areas that may come into contact with the mouth.
4. Do not apply to wounds or irritated skin.
5. After use, wash or bathe treated areas, particularly on children.

Permethrin (Permanone) is a new tick product. Apply it only to clothing, not to skin. It can kill ticks rapidly. Permanone also may have some repellent activity against ticks.

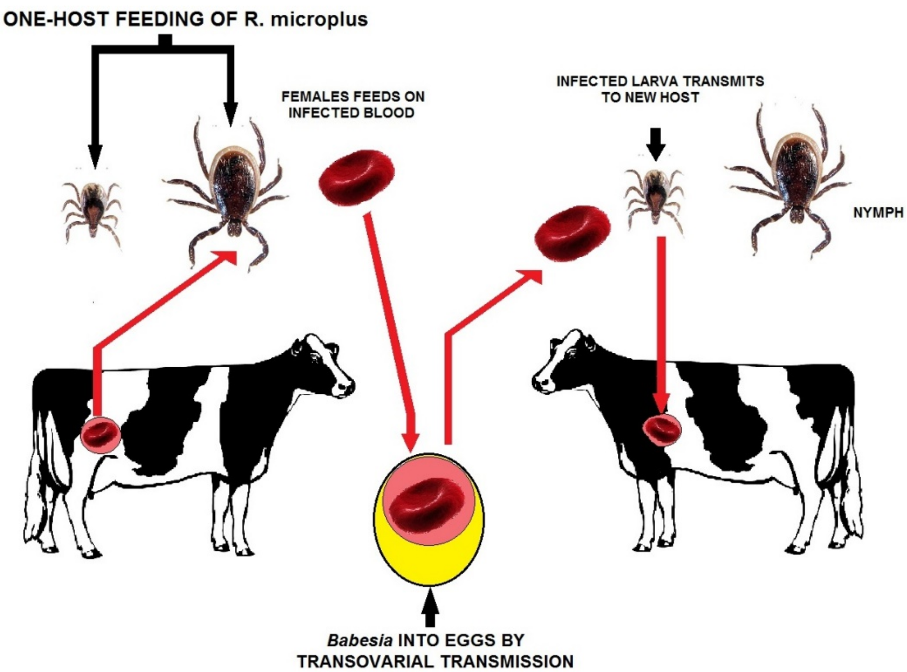
Wear Protective Clothing
Long pants, long-sleeved shirts and other clothing can help exclude ticks or keep them from attaching to the skin. Ticks are usually acquired while brushing against low vegetation, so pulling socks over the bottom of the pants leg also is useful. Light-colored clothing can make it easier to find ticks that have been picked up.

Use Tick Repellents
There are a few effective tick repellents. By far the most common is DEET (N,N-diethyl-metatoluamide), the active ingredient in most common insect repellents, such as Cutters and Off!. Apply DEET directly to the skin or to clothing.
Repellents are most effective if applied to pants and other areas of the lower body likely to come into contact with ticks. DEET can be an effective repellent for ticks as well as other biting arthropods, such as chiggers and mosquitoes.

Conduct Tick Checks
Ticks take several hours to settle and begin feeding. This gives you ample time to detect and remove them. The Rocky Mountain wood tick typically takes 12 to 24 hours to start feeding. Therefore, a thorough "tick check" can be an effective alternative to repellents. After walking through areas where ticks might be present, carefully look for and remove any ticks you may have picked up.

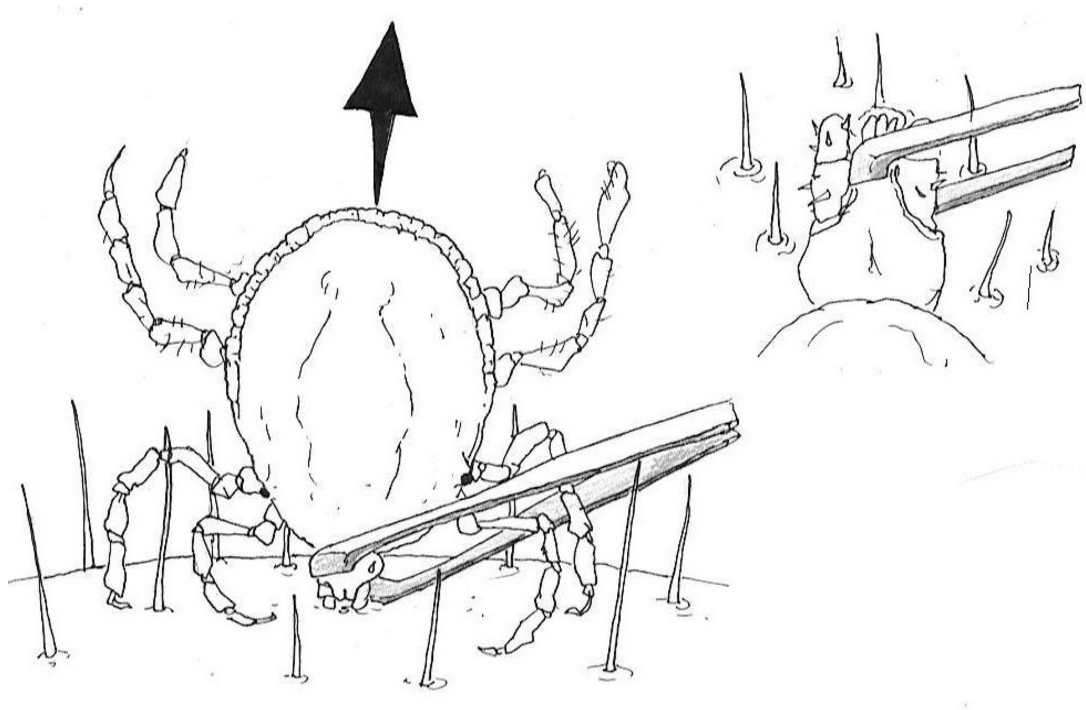
Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator’s legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.



TRANSMISSION OF BABESIOSIS

Tick Removal



HOW TO REMOVE A TICK

To remove a tick, grasp the tick as close to the skin surface as possible. Pull the tick straight upward with steady even pressure. This should remove the tick with the mouthparts intact. Commercial tick removal devices have been shown to vary widely in their efficacy for removing nymphal blacklegged ticks: some worked in every attempt, some failed in every attempt, some were in between. Tick removal devices that have been shown to successfully remove *I. scapularis* nymphs attached for 48 hours in attempts in a recent study include #4 forceps, Original Tick Kit (Tick Kit, Inc.), Pick-Tick (Encepur, Chiron), Pro-Tick Remedy (SCS, Ltd.), and the Nick Nipper (Josyln Designs, Inc.). Squeezing the tick will not increase the risk of infection.

- Watch for signs and symptoms of Lyme disease if the tick is engorged or infected.
- Watch for evidence of secondary infection. Tick bite reactions develop rapidly and can sometimes resemble a small Lyme disease rash, but these transient reactions generally disappear in 24-48 hours and do not control expand like an EM rash.
- Mouthparts left in the skin may cause irritation as the body attempts to absorb or reject the foreign tick tissue (analogous to a minute splinter that is difficult to remove) with a slight risk of secondary bacterial infection. A foreign body granuloma may for weeks, especially if the mouthparts remain. A physician should be consulted if there is evidence of infection.

Tick Bite Prophylaxes

Most medical authorities in the U.S. as the chance of Lyme disease from a known tick bite with *I. scapularis* appears low (< 5%; 0% with flat ticks, 10% with engorged ticks in one study. Only 14-32% of patients diagnosed with Lyme disease remember a feeding tick.

Repellents

DEET

The primary active ingredient in most insect/tick repellents today is DEET (N,N-diethyl-3-methylbenzamide, also known as N,N-diethyl-m-toluamide). DEET is the most effective, broad-spectrum repellent ever discovered, effective against mosquitoes, biting flies, chiggers, fleas and ticks. The U.S. Environmental Protection Agency (EPA) estimates that over one-third of the U.S. population will use a DEET-based product.

There are approximately 230 products containing DEET registered with the EPA (e.g., *Cutter*, *Off*, *Repel, Muskol, Ben's, Sawyer, and others*). Products range in concentration from 5% to 100% DEET and are available as an aerosol can, pump spray bottle, stick, lotion, cream, or towelette for application to skin or clothing. The duration of activity increases with the concentration used.

There are few firm guidelines on the concentration a consumer should use. The effectiveness of DEET on the skin is influenced by the concentration of DEET, absorption through the skin, evaporation, sweating, air temperature, wind, abrasion of the treated surface by rubbing or washing and the arthropod for which protection is desired.

A recent study found that a repellent with 23.8% DEET provided an average of 302 minutes of protection against mosquitoes. Higher concentrations generally provide longer protection, but increasing the concentration does not proportionally increase protection time. Several controlled-release or extended-release DEET formulations have been developed which decrease skin absorption and increase protection time. These products may provide longer protection similar to products with a higher concentration of DEET. All active ingredients and their concentrations are listed on the product label.

DEET and Ticks

DEET will repel ticks and decrease the chances of tick bite, but depending upon the concentration, it may not provide total protection against the blacklegged tick. Not all products with DEET are labeled for ticks. Little is known about the effectiveness of different concentrations of DEET against *I. scapularis*. Concentrations of DEET that might discourage tick attachment may not deter a tick from walking across the skin to unexposed and untreated areas. Some protection against tick attachment appears to come from the oily or creamy nature of some products. When applied to clothes, 30% and 20% DEET was found to be 92% and 86% effective against *I. scapularis*, respectively, but skin applications were reported to be only 75 to 87% effective against crawling ticks in a second study. For blacklegged ticks, DEET concentrations around 30 to 40% will probably be most effective for general use. A recent evaluation of repellent products by Consumer Reports found a 33% DEET cream-based formulation was effective against nymphal *I. scapularis* for at least 9 hours, while 100% DEET kept ticks off for up to 4 hours. Lower concentrations of DEET were also found repellent. The effectiveness of various concentrations of DEET against *I. scapularis*, especially higher (>50%) and lower (<20%) concentrations, needs to be examined more closely under natural use conditions.

Safe Use of DEET

DEET has been used by many millions of Americans for 40 years and the incidence of adverse reactions is low. The Environmental Protection Agency (EPA) conducted a review of DEET and believes that normal use of DEET does not present a health concern to the general population when used according to label directions (Reregistration Decision document available from the EPA).

Some allergic, toxic, and neurological reactions to DEET have been reported in medical literature, but toxic encephalopathic reactions are rare. Reported adverse reactions appear to have involved high concentrations of DEET, over application of product contrary to label directions, or ingestion of product.

Repeated applications have occasionally produced tingling, mild irritation or contact dermatitis. Important points in the safe use of DEET include:

- Follow the directions and precautions given on the repellent label.
- Apply DEET sparingly to exposed skin, and spray on clothing when possible.
- Do not use DEET under clothing or over cuts, wounds, or irritated skin.
- Use the lowest concentration necessary for protection and estimated time of needed protection. Minimize the use of higher concentrations on the skin. Lower concentrations, such as 10% DEET, will provide approximately 2 hours of protection against mosquitoes (but may be less effective against ticks), while a concentration of 24% will provide about 5 hours of protection against mosquitoes.
- A concentration of DEET up to 30% for adults and children over 2 years of age is the maximum concentration currently recommended by the American Academy of Pediatrics (AAP).
- The AAP does not recommend the use of DEET on children under 2 months of age. Apply sparingly to small children.
- AAP precautions suggest DEET should not be used in a product that combines the repellent with a sunscreen as sunscreens are often reapplied periodically. DEET is not water-soluble and will last many hours. Reapplications of DEET may increase the possibility of a toxic reaction to DEET.
- Apply the product to a child yourself. Repellent on a child's hands can end up in the eyes or mouth.
- Wash the hands with soap and water after applying DEET.
- People with certain skin conditions should be cautious about the use of DEET.
- Wash off the repellent with soap and water when returning indoors.
- DEET generally won't harm cotton, wool or nylon. DEET can damage some synthetic fabrics (acetate, rayon and spandex), plastics (watch crystals and eyeglass frames), and car and furniture finishes.
- If you suspect a reaction to DEET (or any other repellent), stop using the product, wash the treated skin, and call a poison control center or contact your physician.

Permethrin-based Repellents

Several products contain 0.5% permethrin (e.g., *Duranon Tick Repellent, Repel Permanone, Sawyer's Permethrin Tick Repellent, Sawyer's Clothing Insect Repellent,* and others), which is for use only on clothing or other fabrics such as mosquito netting or tents. A synthetic pyrethroid insecticide rather than a true repellent, permethrin works primarily by killing ticks on contact with the clothes and can provide high levels of protection against ticks (and mosquitoes).

Permethrin is available as an aerosol spray or pump, mainly in lawn and garden centers or sports stores. Permethrin has a relatively low mammalian toxicity, is poorly absorbed through the skin and is quickly metabolized and excreted by the body, although the EPA does list it as a potential carcinogen.

Permethrin can cause mild skin and eye irritation, but reactions appear uncommon. Important points in the safe use of a permethrin repellent include:

- Follow the directions and precautions given on the repellent label.

- Apply to CLOTHING ONLY. Do not apply to skin. Immediately wash with soap and water if you get material on the skin.
- Do not apply to clothing while it is being worn. Apply before you put the clothing on.
- Apply in a well-ventilated area outdoors protected from the wind.
- Lightly moisten the fabric, do not saturate. Allow drying for 2 hours (4 in humid conditions).
- Allow clothing to dry prior to before wearing.
- Do not treat the clothing more than once every two weeks. Launder treated clothing at least once before retreating.

If you suspect a reaction to DEET, permethrin, or any other repellent, stop using the product, wash the treated skin, and call a poison control center or contact your physician.

Botanical and Other Repellents

Botanical products generally provide less protection time against mosquitoes than DEET or permethrin and, though information is limited, are likely to be even less effective against ticks. Many of these products are not labeled for ticks and do not make tick protection claims. Non-DEET products may contain compounds like IR3535 (ethyl butylacetylaminopropionate), or botanical oils such as 0.05% to 15% citronella, 2% soybean oil, or some other plant oil (i.e. eucalyptus, peppermint, lemongrass, geranium or cedar).

Consumer Reports found that IR3535 repelled *I. scapularis* nymphs for 3-4 hours, and among plant oils tested, only the soybean oil product offered reasonable protection against mosquitoes (it is not labeled for ticks). Botanical repellents, even if they might reduce tick attachment, probably will not stop a tick from walking across the skin to an unprotected area. Avon's Skin-So-Soft Bath Oil, a widely used folklore mosquito repellent protects against mosquito bites for less than 10 minutes and is unlikely to deter ticks.

Medical and safety information about the active ingredients in an insect repellent is available from:

National Pesticide Information Center by telephone (1-800-858-7378) from 6:30 a.m. to 4:30 p.m. Pacific Standard Time or 9:30 a.m. to 7:30 p.m. Eastern Standard Time, 7 days week, except holidays.

Human Lyme disease vaccine

The Food and Drug Administration (FDA) approved a human Lyme disease vaccine, LYMErix (GlaxoSmithKline), which contained recombinant outer-surface protein A (OspA) of *B. burgdorferi*, in December 1998. No human Lyme disease vaccine is currently available in the U.S. at this time.

Apply Pesticides Outdoors to Control Ticks

Pesticides for ticks, known as acaricides, can reduce the number of ticks in your yard. These benefits have been best-studied for *Ixodes scapularis* (the black-legged tick), and include:

- Consistent and timely pest control
- Easy to apply
- Relatively inexpensive
- Safe if applied according to the label

Only small amounts of acaricide applied at the right time of year are necessary. Application should focus on control of nymphal *I. scapularis* ticks, the stage most likely to transmit Lyme disease, anaplasmosis, and babesiosis, by spraying once in May or early June. An October application of acaricide may be used to control adult blacklegged ticks, however, they less commonly transmit disease. The use and timing of acaricides to control other ticks of public health concern is less well studied, but may still be helpful.

If you have health concerns about applying acaricides:

- Check with local health or agricultural officials about the best time to apply acaricide in your area.
- Identify rules and regulations related to pesticide application on residential properties (Environmental Protection Agency and your state determine the availability of pesticides).
- Consider using a professional pesticide company to apply pesticides at your home.

Create a Tick-safe Zone to Reduce Ticks in the Yard

Here are some simple landscaping techniques that can help reduce tick populations:

- Remove leaf litter.
- Clear tall grasses and brush around homes and at the edge of lawns.
- Place a 3-ft wide barrier of wood chips or gravel between lawns and wooded areas to restrict tick migration into recreational areas.
- Mow the lawn frequently.
- Stack wood neatly and in a dry area (discourages rodents).
- Keep playground equipment, decks, and patios away from yard edges and trees.
- Discourage unwelcome animals (such as deer, raccoons, and stray dogs) from entering your yard by constructing fences.
- Remove old furniture, mattresses, or trash from the yard that may give ticks a place to hide.

2017 Changes to EPA's Farm Worker Protection Standard

In late 2015 the Environmental Protection Agency issued the long awaited revision to the Worker Protection Standard (WPS). This law it is now technically active and it will be enforced. Please keep in mind that the WPS covers both restricted use AND general use pesticides. This course is not for worker and/or handler training. Always follow the label and your State Pesticide Agency rules.

This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

Pesticide Alert

Pesticide Safety and Site Security

The Environmental Protection Agency is issuing this *Alert* to all pesticide industry organizations, facilities, and handlers as a precaution during this heightened state of security awareness. This *Alert* highlights some general security areas that companies may want to review to ensure that appropriate measures are being implemented. The EPA's Office of Pesticide Programs has developed this tailored summary of the Agency's Chemical Safety Alert entitled, "*Chemical Accident Prevention: Site Security*," which outlines measures to ensure secure and accident-free operations.

It is important that all pesticide establishments review this information and take appropriate steps to minimize risk. This document is not a substitute for EPA regulations, nor is it a regulation itself. It cannot and does not impose legally binding requirements on the EPA or the regulated community, and the measures it describes may not apply to a particular situation based upon circumstances. The Agency may continue to provide further guidance in the future, as appropriate.

Knowing and Understanding Potential Security Threats

Businesses that manufacture, reformulate, sell, distribute, transport, store, or apply pesticides have long known the importance of risk mitigation steps for the safety of their workers, their customers, and their communities. For manufacturers and reformulators, efforts focus on ensuring that the facility is operated safely on a day-to-day basis. Manufacturers must use well-designed equipment, conduct preventive maintenance, implement up-to-date operating procedures, and employ well-trained staff. Those who distribute pesticides have focused on safe storage and accurate labeling of their products. For the pesticide user community, safety efforts have focused on strictly reading and following all label directions. Today, these efforts aren't necessarily enough.

While many of the steps to ensure an effective security program seem routine, they are ***critical*** to the health and safety of your business, facility, and community. Without effective security procedures, your business may be vulnerable to both internal and external threats, posing risks to yourself and employees, your building and machinery, stored pesticides, and even sensitive business information. If you have mobile pest application equipment, particularly aerial application equipment, special precautions should be taken to protect both your equipment and the surrounding community.

Recommended Considerations in Evaluating Pesticide Security

The security needs and critical control points will differ for every business and facility. However, some of the fundamental security control points include:

- **Securing Buildings, Manufacturing Facilities, Storage Areas, and Surrounding Property:** One of the most fundamental security needs is the prevention of intrusion to areas used to manufacture or store pesticides and other toxic chemicals. Elements of an effective security plan can range from basic fencing, lighting, and locks, to intrusion detection systems, cameras, and trained guards. For more information on basic tips on protecting your site, review the EPA's report "*A Chemical Accident Prevention: Site Security*" listed below in the section entitled "*For More Information."*

- **Securing Pesticide Application Equipment and Vehicles:** Facilities and pesticide businesses should ensure that they have appropriate security protections to prevent intruder access to equipment used in mixing, loading, and applying pesticides. Before operating pesticide application tools and vehicles, handlers must have proper authorization and identification.

- **Aerial Application Equipment:** Security awareness is particularly important for large-scale pesticide application equipment like aircraft and large trucks. The FBI has requested that aerial applicators be vigilant to any suspicious activity relative to the use, training in, or acquisition of dangerous chemicals or airborne application of the same, including threats, unusual purchases, suspicious behavior by employees or customers, and unusual contacts with the public. Any suspicious circumstances or information should be reported to the FBI.

- **Protecting Confidential Information:** As business, safety, and security systems become more reliant on computer and communications technology, the need to secure these systems has grown. Such efforts include contingency planning for power losses, effective monitoring of access ports, adherence to password and backup procedures, and other mechanisms to maintain access for authorized personnel only.

- **Designing Facilities and Equipment to Minimize Risk of Damage:** Whether an intrusion to a computer by a hacker or a physical intrusion of your facility by a vandal or saboteur, it is important to take steps to minimize the extent of damage. For example, in order to prevent damage, the use of sturdy, reliable, and potentially blast-proof materials is essential in the construction of equipment used to transport and apply pesticides.

- **Developing Procedures and Policies that Support Security Needs:** Even the best hardware and staffing budgets are only as effective as the procedures and policies that control their use.
    - Effective hiring and labor relations policies are important to obtain and retain good employees who will support and follow safety precautions. For example, the hiring process should ensure that pesticide handlers have all the requisite training necessary to handle pesticides safely. Background checks of staff that have access to secure areas, particularly those areas where pesticides may be stored, are also necessary.

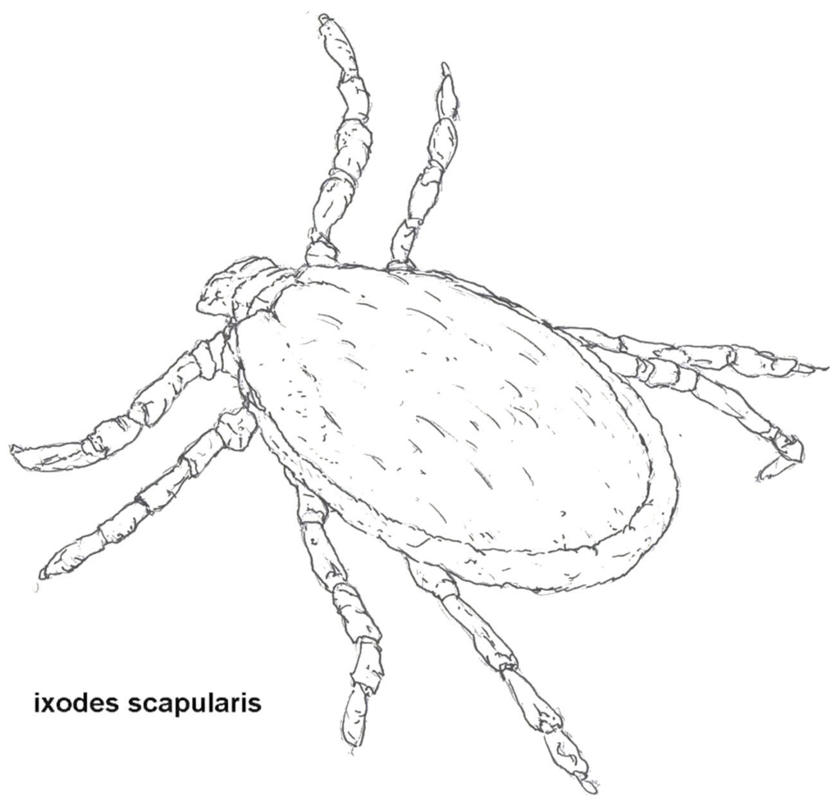
    - Inventory management policies can help limit the amount of potentially hazardous pesticides stored on site, reducing the risks of accidental or intentional release or theft.

    - Effective advance emergency response procedures can be critical, helping ensure that business officials and employees understand how to respond and whom to contact in the case of an emergency. Aside from accidents, such plans must also consider vandalism, bomb threats, and potential terrorist activity.

Tick Control/Treatment Sub-Section

Reduce tick habitat around the home*:** The establishment of homes in wooded areas has increased the potential for contact with wildlife and their ticks. The abundance of ***I. *scapularis* has been directly related to the abundance of white-tailed deer. The elimination of deer or exclusion of deer from large areas by fencing has been shown to reduce tick populations. Substituting landscape plants which are less palatable to deer may discourage browsing around the home. Favorite mouse nesting sites such as stone walls and wood piles can be kept brush free. Firewood and bird feeders should be moved away from the house. Spilled feed from bird feeders may provide mice with a source of food.

Although *I. scapularis* is most abundant in woodlands where hosts for this tick flourish and where high relative humidities necessary for survival of the tick exist, these ticks may also be found on well-maintained lawns, particularly those adjacent to the woods. The majority of *I. scapularis* on lawns have been recovered within 1-2 yards of woodland or stone wall edge.



Close-cut lawns with substantial solar exposure appear to have fewer ticks. Altering the landscape to increase penetration of sunlight and lower the humidity should render the area less hospitable for the tick. Prune trees, mow the lawn, remove leaf litter accumulations, clear underbrush in woodlots, and cut grass, weeds, and brush along edges of the lawn, stone walls, and driveways. The removal of leaf litter has been shown to drastically reduce the number of *I. scapularis* nymphs within the cleared area. Mowing and removing vegetative cover will also discourage rodents. Borders such as tree bark, wood chips, gravel, or similar materials between the woods and lawn edge may also reduce tick abundance on the lawn.

***Chemicals may be used to reduce tick abundance*:** Acaricides (pesticides or insecticides that kill ticks) may be applied to lawns and woodland edges to kill ticks around the home.

Acaricides registered for area tick control are listed alphabetically by active ingredient below with trade names. Some pesticide products are restricted to licensed pesticide applicators. Commercial applicators can be hired to treat for ticks in the yard. The optimum time of application for a spray application to control *I. scapularis* nymphs would be mid-May to early June. It may be possible to treat earlier with a granular formulation. A fall application may be used to control adult ticks. Both liquid and granular formulations have been reported effective against *I. scapularis*. For liquid formulations, use sufficient spray volume and pressure for thorough coverage and penetration of the vegetation and leaf litter. Wooded areas adjacent to the home should be treated for maximum effectiveness. However, even within areas with high rates of human Lyme disease, some properties have been found to have few ticks, which may not justify the application of acaricides.

The pesticide label provides information on the active chemical ingredients, formulation, pests and sites for which it can be legally used, directions for use, precautions, hazards to humans, wildlife and the environment, and first aid instructions. Always read and follow pesticide label directions and precautions. Not all brands of a particular pesticide will be labeled for area tick control, check the label. Medical information about the active ingredients in a pesticide is available from the National Pesticide Telecommunications Network, telephone (800) 858-7378.

Acaricide Selection
Acaricides should only be used if avoidance of tick-infested areas is not an option and ticks are known to occur in the area to be treated. Since no tick control method is 100% effective, personal protection should always be practiced. Use of any chemical tick control method has limited or unpredictable success in reducing black-legged tick populations when used alone, particularly in residential settings. Consider using chemical control only in concert with habitat modification measures. Applications of either liquid acaricides, using high pressure hydraulic sprayers, or granular formulations, which can penetrate into dense foliage, directed against black-legged tick nymphs in late May to early June appear to have the greatest impact on the tick population, thereby reducing exposure to tick-borne diseases. Single applications consistently resulted in control of greater than 90% of nymphs. There is no need for repeated applications at regular intervals during the summer. However, the effectiveness of a single control attempt directed solely against adult or nymphal ticks in small areas will be temporary and limited only to that stage.

Many acaricides available for tick control can be purchased and applied by the general public. READ AND FOLLOW ALL DIRECTIONS ON THE LABEL. Alternative acaricides include soaps and desiccants. Specific acaricides, formulations, and methods of application may be restricted to certain target areas. Users are cautioned to carefully read the acaricide labeling to ensure that the proposed application is not in violation of federal and State pesticide control laws. Contact your Cooperative Extension, your County Agricultural Agent, or pesticide dealer for recommendations.

Pesticide Forms
Pesticides come in both liquid and granular form. Both have various advantages and disadvantages. Generally, granular formulations are easier to apply by the homeowner. Application of liquid formulations requires access to large amounts of water and sophisticated equipment. However, less acaricide is required to achieve adequate control.

Adult ticks are the easiest stage to control. They seek hosts on shrub layer vegetation in the fall and spring. Applying liquid acaricide during this period can result in control exceeding 95%. However, reduction of the adult population does not offer the same public health benefits as the control of nymphs, the life stage responsible for the majority of disease transmission.

Controlling tick nymphs is crucial, but more difficult since they are most active when foliage is present. Successful control of nymphs has been achieved using either granular or liquid formulations of a variety of acaricides. Granular acaricides, which can penetrate into dense foliage, can be applied with a chest-mounted cyclone spreader. Liquid formulations should be applied with sufficient pressure to penetrate foliage and physically disturb leaf litter.

Although control exceeding 90% can be achieved with a single, well-timed application made in late May to early June, such applications will not prevent the emergence of larvae in the summer or the appearance of adults in the fall. Further, these applications appear to be less effective on lone star nymphs and adults, which may coexist in the treated area. Control of tick larvae is generally not recommended because this stage is not infected with the Lyme disease spirochete.

Effectiveness in Controlling Ticks

Blacklegged ticks and American dog ticks are readily killed by almost all ornamental and turf insecticides labeled for tick control. With the withdrawal of the organophosphate insecticides chlorpyrifos and diazinon from residential use (the U.S. Environmental Protection Agency has cancelled registration of these compounds for residential area-wide use), the synthetic pyrethroid insecticides are the most commonly used tick control agents.

Pyrethroids are particularly effective at rates 6-45 times less than the now cancelled organophosphate insecticides and the carbamate insecticide carbaryl. Synergized pyrethrin was more effective when combined with insecticidal soap or as part of a silicon dioxide (from diatomaceous earth) product. Silicon dioxide acts as a desiccant. Thorough coverage appears particularly important with pyrethrin and insecticidal soap products. With the exception of a desiccant, there is little residual activity. At least two applications may be required.

Liquids should be allowed to dry thoroughly before humans or pets reenter the area. Be especially careful using such materials near bodies of water -- do not contaminate water. Wear gloves and eye protection and do not eat or smoke when applying any pesticide. Wash skin and clothing after application, and always launder pesticide-contaminated clothing separately. CAREFULLY READ AND FOLLOW ALL PRODUCT DIRECTIONS.

An Acaricide Primer

The purpose of this section is to serve as a reference for some basic, general material on the major classes of chemicals used in tick control. More detailed information is available from the EPA, the Cooperative Extension Service, state pesticide agencies, and independent groups, particularly over the Internet. Some sources of information are listed at the end of this section. Acaricides belong to a variety of chemical classes, which differ in their chemistry, mode of action, toxicology, and environmental impacts. They also contain “inert ingredients,” chemicals that carry or enhance the application or effectiveness of the active ingredient (i.e., the actual acaricide). A variety of pesticides are also used in products to control ectoparasites on pets. Some pet care products are available over the counter and others through a veterinarian.

Pesticide Use
Insecticides, or as termed for ticks, acaricides, are the most effective way to reduce ticks, particularly when combined with the landscaping changes to decrease tick habitat. Acaricides provide consistent control, are relatively easy to apply, and are relatively inexpensive. Only small amounts of an acaricide applied at the right time of year are necessary. Chemical intervention should focus on early control of nymphal stage in May or early June. Summer and fall applications target mostly adult ticks. Targeting lawn and woodland edges and perimeter areas near tick "hot-spots" or along the "tick zone" can minimize exposure.

Some general points to consider if you spray for ticks:
• Applications can be made by the homeowner or by a commercial applicator.
• A single application of most ornamental-turf insecticides will provide 85-90% or better control with some residual activity so multiple applications are rarely necessary. Some organic pesticide products are less effective, breakdown rapidly, and multiple applications may be required.

Research has demonstrated the effectiveness of properly timed acaricide applications. If ticks are present, treat edge areas of the property where turf grass and woods meet) plus 12 feet into the woods to create a protective barrier. Shady areas of the lawn adjacent to the woods and areas landscaped with shrubs and ground covers such as pachysandra may also be treated.

Classes of Pesticide

Examples
Carbamates -Carbaryl
Pyrethroids -Permethrin, deltamethrin, cyfluthrin
Pyrethrums- Plant extracts called pyrethrins, primarily for use inside the home because they break down so quickly.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

Acaricides (pesticides) that are registered for the control of ticks in most States (please check with your Pesticide Regulation Agency) include the following 7 chemicals. Most acaricides can provide good control of the blacklegged tick.

- **Carbaryl** (Sevin, other brands). This material belongs to a class of pesticides called carbamates. Carbaryl may be used against ticks on turf and recreational areas. There are numerous brands available for public use. Both sprays and granules have been reported effective against ticks.
- **Chlorpyrifos** (Dursban, other brands). This material belongs to a class of pesticides called organophosphates. Chlorpyrifos may be used against ticks on turf and recreational areas. Some products are available for public use; other formulations are restricted to licensed applicators. Sprays and granules reported effective against ticks. All uses will be banned in the near future.
- **Cyfluthrin** (Tempo). This material belongs to a class of pesticides called synthetic pyrethroids. Cyfluthrin may be used against ticks on turf and ornamentals. This product is available for commercial use only. It is effective against blacklegged ticks.
- **Diazinon** (Diazinon, other brands). This material belongs to a class of pesticides called organophosphates. Some products available to the public, but many restricted by label to commercial use. Sprays and granules moderately effective against blacklegged ticks.
- **s-fenvalerate** (Zema Lawn Spray). This material belongs to a class of pesticides called synthetic pyrethroids. This product may be used against ticks on lawns and backyards. It is a hose sprayer kit for homeowner use.
- **Fluvalinate** (Mavrik Aquaflow, Yardex). This material belongs to a class of pesticides called synthetic pyrethroids. Fluvalinate may be used against ticks on turf and ornamentals. This material is effective against blacklegged ticks.
- **Permethrin** (PermaKill 4Week Tick Killer). This material belongs to a class of pesticides called synthetic pyrethroids. It is labeled for use against ticks on the lawn.

Permethrin (host-targeted permethrin-treated cotton balls)--Permethrin is highly effective as a clothing toxicant against ticks. . Commercially available permethrin-treated cotton balls (*Damminix*®) target larvae and nymphs of *I. scapularis* on white-footed mice. Tubes filled with cotton are distributed throughout the mouse habitat, and mice collect the cotton as nesting material.

Ticks on the mice are killed, which in turn, is supposed to ultimately reduce the number of infected ticks on a treated property. However, studies in Connecticut and New York State failed to show any reduction in the number of infected, host-seeking *I. scapularis* nymphs when the permethrin-treated cotton balls were applied over a three year period in woodland or residential areas of about 4 acres or less. Nymphal reductions were reported in a Massachusetts study with the treatment of one 18 acre site.

Tables

Table 1. Repellents labeled for tick management. *

Common Name	Homeowner Product*
Deet	Cutter (28.5%) Muskol (25%) Off (14.25%) Off (Deep Woods) (28.5%) Ultrathon Lotion (31.0%)
Permethrin	Repel (Permanone Insect Repellent) (0.5%) (clothes only)
***Read label carefully to insure pest, site, and commodity are listed prior to applying product. Some product labels are very restrictive.**	

Table 2. Tick management products labeled for indoor surface or crack and crevice treatment.*

Common Name	Homeowner Products	Commercial Products
Beta-Cyfluthrin	Bayer Power Force Carpenter Ant & Termite Killer Plus	
Bifenthrin	Ortho Home Defense Perimeter & Indoor Insect Killer	Talstar F Inseciticide/Miticide Talstar Termiticide/Insecticide
Cyfluthrin		PT Cy-Kick Crack & Crevice Pressurized Residual

		PT Cy-Kick CS Controlled Release Cyfluthrin PT Cy-Kick CS Crack & Crevice Pressurized Residual
Cypermethrin		Cynoff EC Cynoff Power Spray Insecticide Cynoff WP Cynoff WSB Prevail FT Termiticide
Deltamethrin		Suspend SC Insecticide
Lambda Cyhalothrin		PT 221L
Permethrin	Ortho Bug-B-Gon Multipurpose Garden Dust	Dragnet SFR Termiticide/Insecticide
Pyrethrins		Kicker PT Tri-Die Silica & Pyrethrum Dust PT ULD BP-300
Pyrethrins and Others		PT Microcare CS Controlled Release Pyrethrum PT Microcare Pressurized Pyrethrum Capsule Suspension PT Pro-Control PT Pro-Control Plus PT Tri-Die Pressurized Silica & Pyrethrin Dust PT ULD BP-100

		Tri-Die Silica & Pyrethrum Dust
Pyrethrins, MGK-264, Permethrin	Ortho Ant-B-Gon	
Pyrethrins, PBO		PT P.I. Contact Insecticide PT ULD BP-50 Pyrenone 50 Synerol Insecticide
Pyrethrins, PBO, Silica Gel		Drione
Tau-Fluvalinate		Yardex Supplemental Labeling
Tetramethrin, Phenothrin	Ortho Flying Insect Killer 1	
Tralomethrin		Saga WP Insecticide
*** Read label carefully to insure pest, site, and commodity are listed prior to applying product. Some product labels are very restrictive.**		

2017 Changes to EPA's Farm Worker Protection Standard

In late 2015 the Environmental Protection Agency issued the long awaited revision to the Worker Protection Standard (WPS). This law it is now technically active and it will be enforced. Please keep in mind that the WPS covers both restricted use AND general use pesticides. This course is not for worker and/or handler training. Always follow the label and your State Pesticide Agency rules.

This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

Table 3. Tick management products labeled for indoor space treatment.*

Common Name	Homeowner Products	Commercial Products
Pyrethrins		PT ULD BP-300
Pyrethrins and Others		PT Pro-Control PT Pro-Control Plus PT ULD BP-100
Pyrethrins, PBO		PT ULD BP-50
Pyrethrins, Permethrin	Ortho Indoor Insect Fogger	
*** Read label carefully to insure pest, site, and commodity are listed prior to applying product. Some product labels are very restrictive.**		

Inert ingredients. They may be solvents, propellants, spreaders, stickers, wetting agents, or carriers for the active pesticide chemical. Because these compounds are not the active chemical, they are labeled “inert ingredients” or sometimes “other ingredients”. These compounds often make up the major part of a pesticide formulation. In some cases, the inert ingredients may be more toxic than the active ingredient. A few examples of inerts include napththalene, petroleum distillates, and the organic solvents xylene and toluene.

Acaricides for control of ticks on pets. Carbaryl and the pyrethroid permethrin are used in several flea and tick control products for dogs. Studies have indicated that use of permethrin products (i.e., K9 Advantix, Kiltix) can prevent the transmission of *B. burgdorferi* and *A. phagocytophilum*. Both are topical products applied to spots along or on the back of the animal. They are not for use on cats, as cats are particularly susceptible to pyrethrin poisoning. Fipronil, a phenypyrazole, is the only commercial insecticide of this chemical type. Formulated pet products are available as a spray or topical spot application (Frontline, Top Spot, FrontlinePlus) for long-term control of fleas and ticks on dogs and cats. It is the material used in the Maxforce TMS rodent bait box. Fipronil dissolves in the oils on the skin, spreads over the body, and collects in sebaceous glands and hair follicles for long-term reapplication. It is not affected by bathing or water immersion. Skin irritation may occur. Fleas are killed from 1-3 months, while ticks are killed for about a month. Trizapentadiene or formanidene compounds include one currently used material, amitraz. In livestock, it is used to control 7 ticks, mites, and lice. It is not a skin irritant, is not readily absorbed into tissue, and degrades rapidly in the environment. Amitraz is used in a tick prevention collar for dogs (Preventic), and one study indicated it could prevent transmission of *B. burgdorferi*. An amitraz product was one of the compounds initially evaluated for the topical treatment of deer to control *I. scapularis*.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully.
For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

Additional sources of information about pesticides
Environmental Protection Agency (EPA) Public Information Center (telephone 202-260-2080), National Center for Environmental Publications and Information (telephone 513-489-8190), EPA booklets or the EPA web site (www.epa.gov).

Extension Toxicology Network (EXTOXNET) is a cooperative effort of University of California-Davis, Oregon State University, Michigan State University, Cornell University, and the University of Idaho. Primary files are maintained and archived at Oregon State University. Pesticide Information Profiles (PIPs) and Toxicology Information Briefs (TIBs) provide information on pesticide trade names, regulatory status, acute and chronic toxicological effects, signs and symptoms of poisoning, ecological effects and environmental fate, physical properties, manufacturer, and references (http://ace.orst.edu/info/extoxnet/).

State pesticide regulatory agencies can provide information on the laws and regulations governing the application of insecticides, certification of pesticide applicators, and which products are registered for use in the state. Depending upon the state the agency may be associated with the state Department of Agriculture, Consumer Protection, or Environmental Protection.

Research on control of ticks is ongoing. Workers have shown that by using registered insecticides at the proper time, tick contact may be greatly reduced. Treating with an insecticide does not guarantee, however, that no ticks will be present. People still need to protect themselves by dressing appropriately, using repellents when in potentially tick-infested areas and checking daily for the presence of ticks (and removing them if found).

Safety Tips for Pet Owners

- Consult your veterinarian about the best way to to protect your pets from fleas and ticks and whether pesticides are even needed.
- Do not apply to kittens or puppies unless the product label specifically allows this treatment. Pay attention to the age restrictions for puppies and kittens on the label.
- Follow any label prohibitions against use on weak, aged, medicated, sick, pregnant, or nursing pets, or on pets that have previously shown sensitivity to pesticide products. Apply only the amount indicated for the size of the animal being treated.
- If you use a spot-on product or any other pesticide on your pet, carefully read and follow the product label.
- If your pet experiences an adverse reaction, immediately bathe the pet with mild soap and rinse with large amounts of water.
- Keep the package with the product container (such as individual applicator tubes). Also keep the package after treatment in case adverse effects occur. You will want to have the instructions at hand, as well as contact information for the manufacturer.
- Monitor your pet for side effects or signs of sensitivity after applying the product, particularly when using the product on your pet for the first time. Do not apply spot-ons to pets known to be sensitive to pesticide products.
- Use extra care before use on weak, aged, medicated, sick, pregnant, or nursing pets, or on pets that have previously shown signs of sensitivity to pesticide products.
- Use flea and tick control products only on the animal specified by the product label - for example, dog products for dogs only and cat products for cats only.

Flea and Tick Control Tips

The following tips may help to prevent, reduce, or eliminate flea infestations:

- Consider keeping pets indoors.

- Flea combs are very effective tools in the suppression of adult fleas. They allow hair to pass through the tines but not the fleas, removing fleas as well as flea feces and dried blood. Focus combing on those parts of the pet where the most fleas congregate, usually the neck or tail area. When fleas are caught, deposit them in hot soapy water to kill them.

- Steam cleaning carpets may also help as the hot steam and soap can kill fleas in all stages of the life cycle. Pay particular attention to areas where pets sleep.

- Vacuuming on a daily basis to remove eggs, larvae and adults is the best method for initial control of a flea infestation. It is important to vacuum the following areas: carpets, cushioned furniture, cracks and crevices on floors, along baseboards and the basement.

- Wash all pet bedding and family bedding on which pets lie in hot, soapy water every two to three weeks. If an infestation is severe, discard old pet bedding and replace it with fresh, clean material.

The Centers for Disease Control and Prevention suggests the following ways to reduce ticks in your yard:

- Discourage deer. Removing plants that attract deer and constructing physical barriers may help discourage deer from entering your yard and bringing ticks with them.

- Modify your landscape to create Tick Safe Zones. To do this, keep play areas and playground equipment away from shrubs, bushes, and other vegetation. Also, regularly remove leaf litter and clear tall grasses and brush around homes, and place wood chips or gravel between lawns and wooded areas to keep ticks away from recreational areas.

- Provide a vegetation-free play area. Keep play areas and playground equipment away from away from shrubs, bushes, and other vegetation.

- Use a chemical control agent. Effective tick control chemicals are available for use by the homeowner, or they can be applied by a professional pest control expert, and even limited applications can greatly reduce the number of ticks. A single springtime application of acaricide can reduce the population of ticks that cause Lyme disease by 68-100%.

Table 4. Tick management products labeled for outdoor treatment.*

Common Name	Homeowner Trade Name	Commercial Trade Name
Beta-Cyfluthrin	Bayer Power Force Carpenter Ant & Termite Killer Plus	
Bifenthrin	Ortho Lawn Insect Killer Granules	Talstar CA Granular Insecticide Talstar EZ Granular Insecticide Talstar F Insecticide/Miticide Talstar GC Granular Insecticide Talstar PL Granular Insecticide Talstar Termiticide/Insecticide
Cyfluthrin	Bayer Advanced Home, Home Pest Control Indoor & Outdoor Insect Killer Bayer Advanced Lawn & Garden Multi-Insect Killer Bayer Power Force Ant Killer Ready-to-Use Granules Bayer Power Force Multi-Insect Killer Ready-to-Spread Granules	Tempo 20 WP Tempo SC Ultra
Deltamethrin		DeltaGard G Suspend SC Insecticide

Esfenvalerate	Ortho Bug-B-Gon Multipurpose Insect Killer	
Permethrin		Astro Insecticide Dragnet SFR Termiticide/Insecticide
Pyrethrins		Kicker
Tralomethrin		Saga WP Insecticide
*** Read label carefully to insure pest, site, and commodity are listed prior to applying product. Some product labels are very restrictive.**		

Footnotes

1. This document is ENY-206, one of a series of the Entomology and Nematology Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Publication date: June 1991. Revised: February 2003. Please visit the EDIS Website at **http://edis.ifas.ufl.edu**. Additional information on these organisms, including many color photographs, is available at the Entomology and Nematology Department website located at **http://entnemdept.ifas.ufl.edu**.

2. P. G. Koehler, professor/extension entomologist and F. M. Oi, assistant extension entomologist, Entomology and Nematology Department, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL 32611.

The use of trade names in this publication is solely for the purpose of providing specific information. UF/IFAS does not guarantee or warranty the products named, and references to them in this publication does not signify our approval to the exclusion of other products of suitable composition. Use pesticides safely. Read and follow directions on the manufacturer's label.

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University of Florida, Institute of Food and Agricultural Sciences (UF/IFAS)

Chemical Control of Ticks - Summary

Outdoors

Insecticides or acaricides. Several insecticides and acaricides provide effective control of tick populations in small infested areas. At least two treatments are required for control; one in the spring for adult and nymphal stages and the other in late summer for larval stages. Surveillance is necessary to determine times of application (see Monitoring section for techniques).

Low to moderate infestations can usually be controlled by one spring and one late summer treatment; heavy infestations may need two or more treatments in the spring and again in late summer and early fall.

Consult your regional Integrated Pest Management coordinator to determine pesticide choice and application rates.

Aerial dispersal of acaricides requires coordination with local, state, and sometimes federal officials. Chrlorpyrifos in a 14% granular formulation applied at 7 lb/acre has been used successfully in tick control by this method (Goddard 1989).

Vegetation management by herbicides is another tick control option. It produces the same benefits as mechanical management of vegetation; i.e., reduced harborages for animal hosts of ticks, reduced soil humidity, and increased soil temperature, all of which are detrimental to tick survival.

Management of vegetation by herbicidal and mechanical methods may not always produce comparable results; Hoch et al. (1971) found that herbicidal treatment of woodlots was not as effective as mechanical vegetation clearing in reducing the population of Lone Star ticks.

For outdoor areas, habitat reduction by mechanical removal of excess brush and overstory and regular mowing of grass 6" or less in height is recommended. Regular CO_2 or drag surveys of likely tick habitats will indicate locations where treatment is required. If non-chemical measures prove ineffective, registered herbicides (for vegetation management) or acaricides (for direct kill) may be needed.

Animal-proofing park buildings through the use of exclusion techniques should eliminate indoor tick habitats and reduce the chance of future infestations.

Recommended procedures for protection of park personnel and visitors include frequent examination of the clothing and body of any person traveling through tick habitats, wearing protective clothing, and the use of clothing and/or skin-applied tick repellents.

Indoors

Sites such as crevices, baseboards, trimming, furniture, ceilings, floors/carpets, walls behind pictures, bookshelves, and drapes should be spot-treated as needed. Crack and crevice treatments should be done with residual dusts or silica gel. This is the most effective way to use pesticides in a building. Fumigation does not work well in buildings because ticks can readily re-enter through doorways or windows.

Personal Protection

Ticks can be prevented from attaching to the skin or clothing by the use of repellents. Schreck et al. (1980) reported that DEET, M-1960, and permethrin provided 81%, 95%, and 89% protection, respectively, against the Lone Star tick. Mount and Snoddy (1983) showed that the application of pressurized sprays of 20% DEET to the exterior of surfaces of clothing provided 85% protection against nymphal and adult Lone Star ticks and 94% protection against adult American dog ticks. Permethrin (0.5%) gave 100% protection against both species.

However, DEET and M-1960 have a disagreeable odor and can cause skin irritations. The most effective repellent/toxicant against all tick species available at present is Permanone (0.5% permethrin), which must be used as a clothing treatment; Permanone is not intended to be sprayed directly onto the skin (Goddard 1989). Permanone remains effective for at least 1 month on unwashed clothing. All pesticide-treated clothing must be washed separately.

Introduction to Ticks Section Post Quiz

Fill-in-the-blank

Unfed Adult Stage Characteristics
Scutum (shield) pattern
1. Ticks have a dorsal scutum or "shield" and each species has a unique pattern or color. *Ixodes* ticks often have a black/brown solid colored scutum. Whereas, *Dermacentor* and *Amblyomma* ticks each have a ___________________.

Festoons
2. Festoons are small areas separated by short grooves on the back margin of the tick and helps distinguish all other ticks from ____________, which lack festoons.

3. Soft ticks have no_________________.

4. Some mites are parasitic but all ticks are parasitic feeders on blood. Some species of mites may be mistaken for __________________at infestations but their feeding mechanisms are distinctive.

5. All ticks have________________: after hatching from the egg a series of similar stages (instars) develop from a six legged larva, to eight legged nymph and then a sexually developed eight legged adult.

Anatomy and physiology
6. Ticks, like mites, have bodies which are divided into two primary sections: the anterior *capitulum* (or *gnathosoma*), which contains the head and mouthparts; and the posterior ______________which contains the legs, digestive tract, and reproductive organs.

7. Ticks are incapable of flying or jumping, but many tick species wait in a position known as "_______________".

Ixodidae
8. Ixodid ticks require______________, and their life cycle takes at least one year to complete.

Genus *Dermacentor*
9. Some species feed regularly on man and other animals; transmit the causative organisms of spotted fever, tularemia, Colorado tick fever, possibly______________, and anaplasmosis; and pass many of the causative agents of these diseases transovarially and transstadially.

Genus Ornithodoros
10. Ornithodoros is the most important of the four genera of soft ticks. The ticks in this genus have a more globular body without the sutural line found in the various species of Argas. The body is roughened or warty in appearance with tiny protuberances, called "___________________."

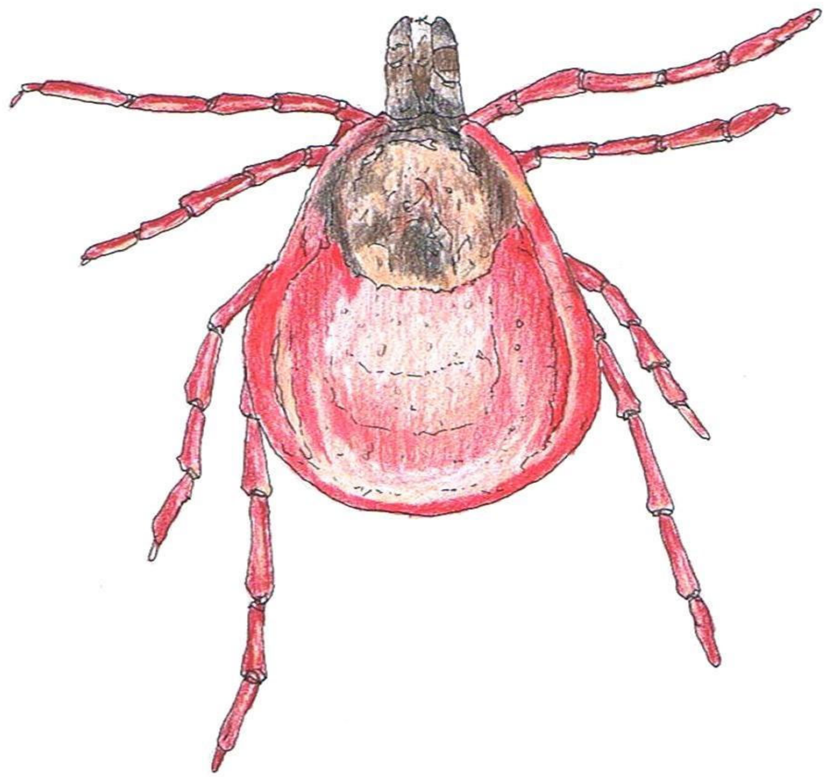
Introduction to Ticks Post Quiz Answers
1. A patterned scutum **,** 2. Ixodes ticks **, 3.** Hard shell (Scutum), 4. Larval ticks, 5. An incomplete metamorphosis, 6. Idiosoma, 7. Questing, 8. Three hosts, 9. Q fever, 10. Mammillae

Topic 13 - Tick Identification Section

Section Focus: You will learn the basics of tick identification. At the end of this section, you will be able to describe various ticks. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Out of over 50,000 named species of Acari, approximately ~ 970 are tick species. The order Ixodida is presently subdivided into four families: Ixodidae (~ 750 spp.), Argasidae (~ 218 spp.), Nuttalliellidae (monotypic) and Deinocrotonidae (monotypic, but extinct). Tick species of medical and veterinary importance are included in the families Argasidae (soft ticks) and Ixodidae (hard ticks), which are the principal focus of this section.

Quick Reference of Common Ticks



BLACK LEGGED TICK

The most common ticks in the United States are the black legged ticks (which can carry the organisms known to cause Lyme disease, anaplasmosis, babesiosis, and Powassan disease), Lone Star ticks (which can carry the organisms that cause ehrlichiosis, tularemia and the Southern Tick-Associated Rash Illness (STARI)), and American dog ticks (which can carry the organisms which cause Rocky Mountain spotted fever and tularemia).

Many tick-borne diseases, such as Lyme disease, babesiosis, ehrlichiosis and Rocky Mountain spotted fever can be treated effectively if caught early.

Be sure to mention to your doctor any history of tick bites, or outdoor activities where you might have been exposed to ticks. Many people who become ill do not even remember seeing a tick.

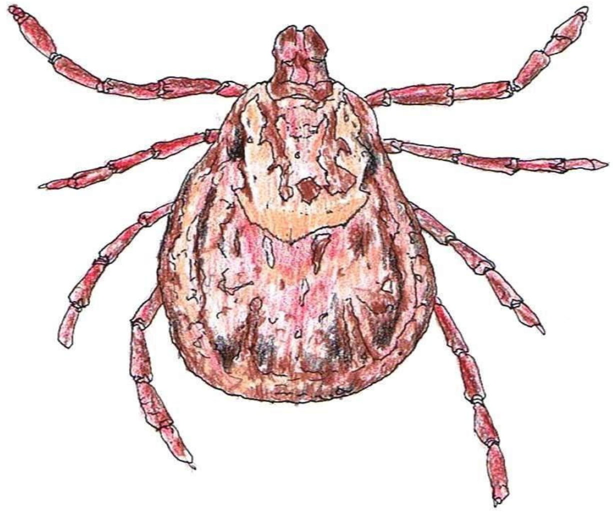
Where found: Widely distributed in the northeastern and upper midwestern United States.

Transmits: Lyme disease, anaplasmosis, babesiosis, and Powassan disease.

BLACK LEGGED TICK

Comments: The greatest risk of being bitten exists in the spring, summer and fall. However, adults may be out searching for a host any time winter temperatures are above freezing. Stages most likely to bite humans are nymphs and adult females.

American Dog Tick

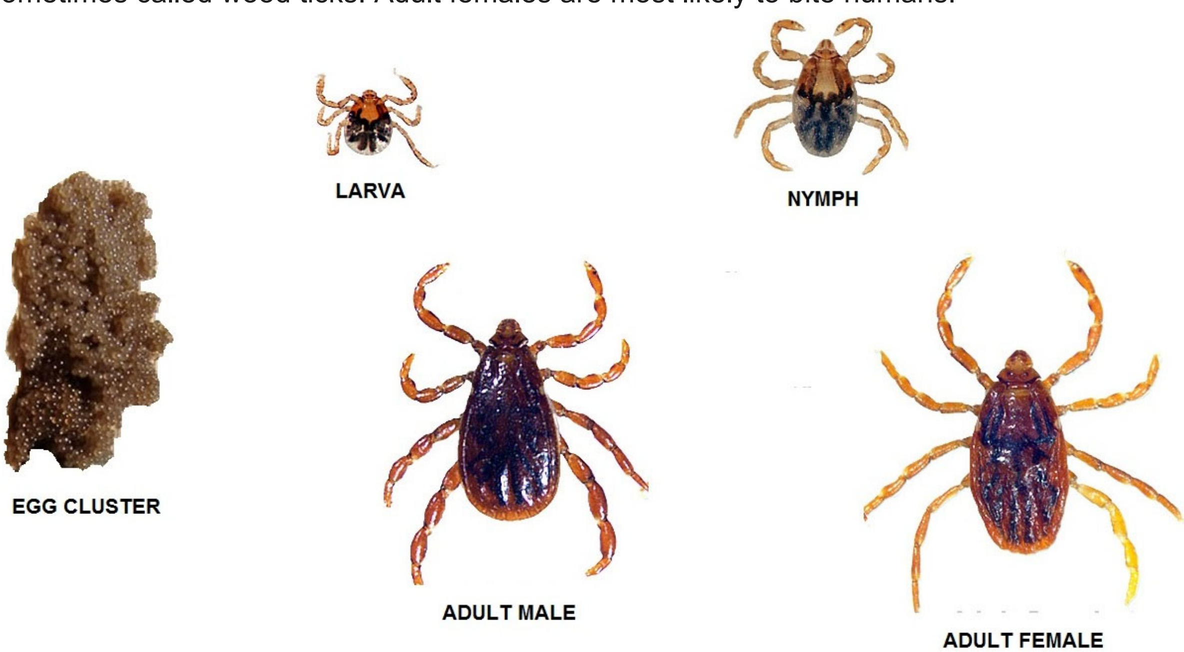


AMERICAN DOG TICK

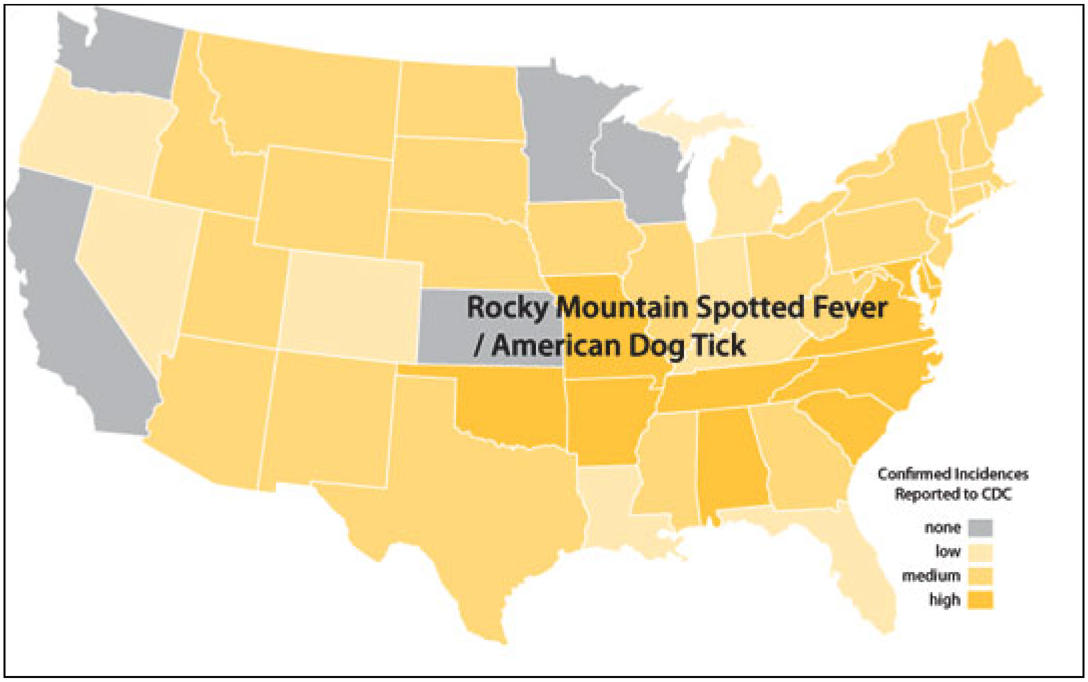
Dermacentor variabilis **Where found:** Widely distributed east of the Rocky Mountains. Also occurs in limited areas on the Pacific Coast.

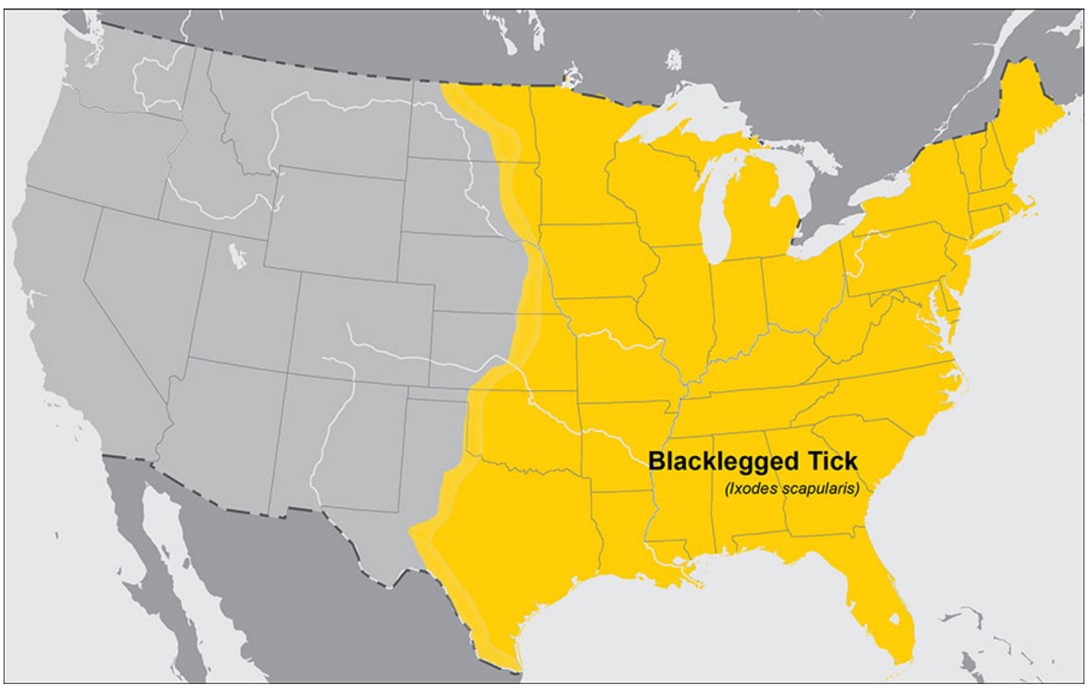
Transmits: Tularemia and Rocky Mountain spotted fever.

Comments: The highest risk of being bitten occurs during spring and summer. Dog ticks are sometimes called wood ticks. Adult females are most likely to bite humans.

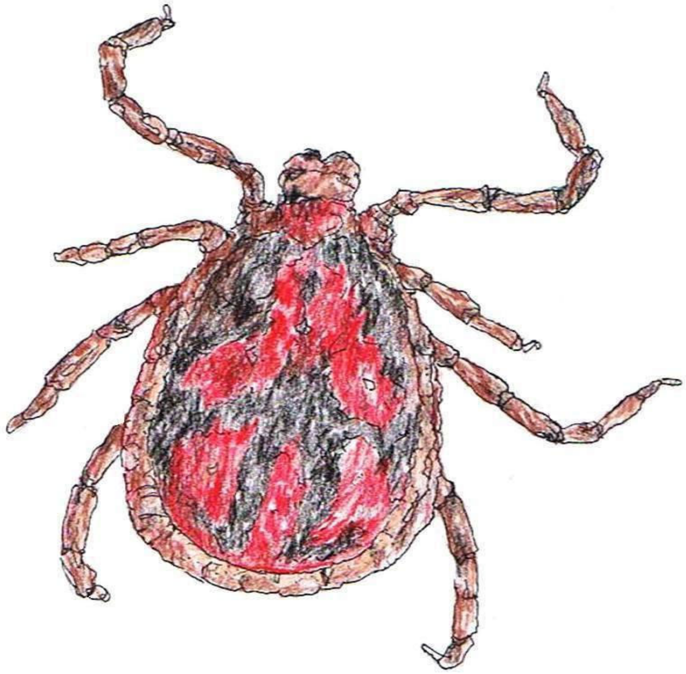


AMERICAN DOG TICK LIFE CYCLE STAGES


Rocky Mountain Spotted Fever / American Dog Tick
Confirmed Incidences Reported to CDC
none
low
medium
high


Blacklegged Tick
(Ixodes scapularis)

Brown Dog Tick, *Rhipicephalus sanguineus* (Latreille)



BROWN DOG TICK
Rhipicephalus sanguineus

Where found: Worldwide.

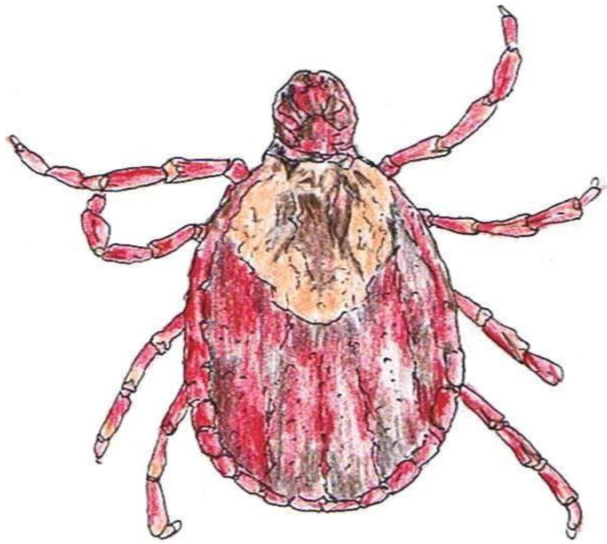
Transmits: Rocky Mountain spotted fever (in the southwestern U.S. and along the U.S.-Mexico border).

Comments: Dogs are the primary host for the brown dog tick in each of its life stages, but the tick may also bite humans or other mammals.

The brown dog tick or kennel tick, *Rhipicephalus sanguineus*, is a three-host tick found almost worldwide and throughout the United States. The tick is more abundant in the southern states. This is the only species of this genus in the U.S. Domestic dogs are the principal host for all three stages of the tick, especially in the United States, although the tick feeds on other hosts in other parts of the world. Adult ticks feed mainly inside the ears, head and neck, and between the toes, while the immature stages feed almost anywhere, including the neck, legs, chest, and belly. People may occasionally be attacked.

This tick is closely associated with yards, homes, kennels and small animal hospitals where dogs are present, particularly in pet bedding areas. In the North, this tick is found almost exclusively indoors. Brown dog ticks may be observed crawling around baseboards, up the walls or other vertical surfaces of infested homes seeking protected areas, such as cracks, crevices, spaces between walls or wallpaper, to molt or lay eggs. A female tick can deposit between 360 to 3,000 eggs. Under favorable conditions, the life cycle can be completed in about two months. This tick is the vector for canine ehrlichiosis (*Ehrlichia canis*) and canine babesiosis (*Babesia canis* or *Babesia gibsoni*). The brown dog tick is a vector for Boutonneuse fever in Europe and Africa.

Rocky Mountain Tick



ROCKY MOUNTAIN TICK
Dermacentor andersoni

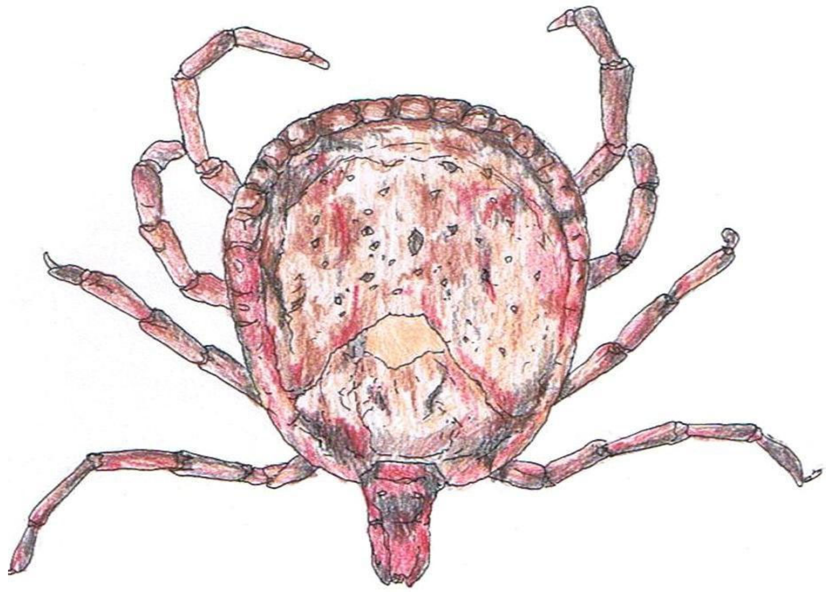
Where found: Rocky Mountain states and southwestern Canada from elevations of 4,000 to 10,500 feet.

Transmits: Rocky Mountain spotted fever, Colorado tick fever, and tularemia.

Comments: Adult ticks feed primarily on large mammals. Larvae and nymphs feed on small rodents. Adult ticks are primarily associated with pathogen transmission to humans.

ROCKY MOUNTAIN WOOD TICK LIFE CYCLE STAGES

Lone Star Tick



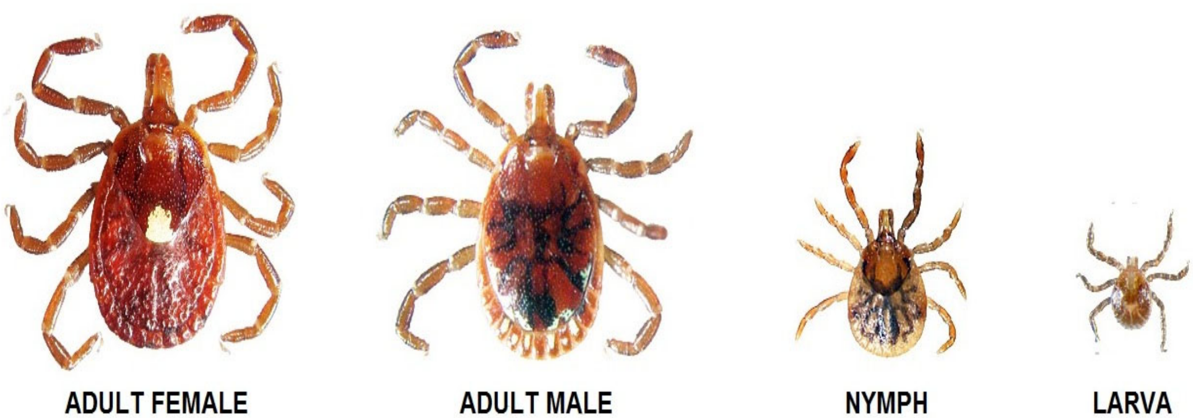
LONE STAR TICK

Amblyomma americanum

Where found: Widely distributed in the southeastern and eastern United States.

Transmits: *Ehrlichia chaffeensis* and *Ehrlichia ewingii* (which cause human ehrlichiosis), tularemia, and STARI.

Comments: A very aggressive tick that bites humans. The adult female is distinguished by a white dot or "lone star" on her back. Lone star tick saliva can be irritating; redness and discomfort at a bite site does not necessarily indicate an infection. The nymph and adult females most frequently bite humans and transmit disease.



LONE STAR TICK LIFE CYCLE STAGES

Deer Tick

DEER TICK

Tick Life Cycle

Deer Tick Life Cycle

The deer tick passes through four life stages (egg, larva, nymph, adult), over a two year period

Egg to Larvae

Eggs are fertilized in the fall and deposited in leaf litter the following spring. They emerge as larvae in late summer of that year, seeking their first blood meal. The tiny larva crawls around the forest floor and onto low-lying vegetation looking for an appropriate host. Their first host is generally a mouse or other medium-sized mammal or bird. Once attached, the larvae embed their mouth parts and feed for several days. If the host is infected with a disease such as Lyme, the tick may be infected during this feeding. The larvae then drop off their host into the leaf litter where they molt into the next stage, the nymph, remaining dormant until the following spring.

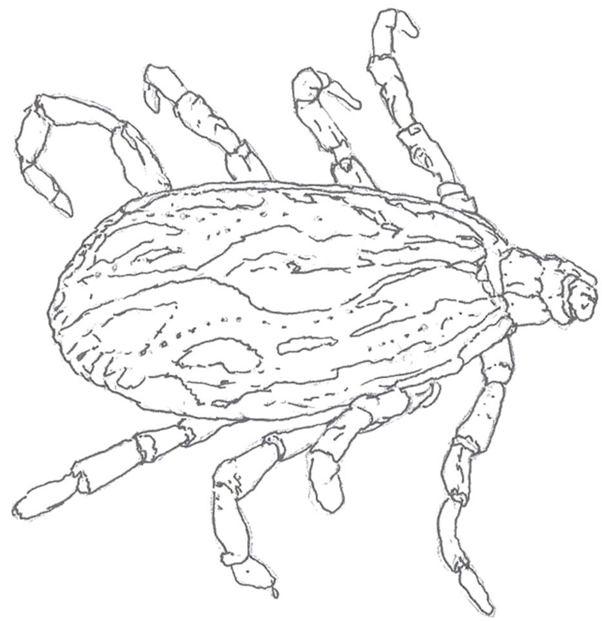
Larvae to Nymph

During the spring and early summer of the next year the nymphs end their dormancy and begin to seek a host. Nymphs are commonly found on the forest floor in leaf litter and on low lying vegetation. Their host primarily consists of mice and other rodents, deer, birds and unfortunately humans. Most cases of Lyme disease are reported from May through August, which corresponds to the peak activity period for nymphs. This suggests that the majority of Lyme disease cases are transmitted by nymphal deer ticks. After feeding for several days the nymph ticks drop off to the forest floor.

Nymph to Adult

Over the next few months the nymph molts into the larger adult tick, which emerges in fall, with a peak in October through November. Both male and female adults find and feed on a host, and then the females lay eggs sometime after feeding.

Pacific Tick



PACIFIC TICK
Dermacentor occidentalis

Overview
Pacific Coast ticks are human-biting ticks with a broad host range, found predominantly in shrublands, chaparral, and along trails from Oregon to northern Baja California and Mexico. Pacific Coast ticks are the most common tick found nearly throughout California but are easily confused with other less common Dermacentor ticks found along the western coastal regions of the U.S (D. variabilis, D. andersoni, D. albipictus.

All life stages of this tick can transmit Rocky Mountain spotted fever (Rickettsia rickettsii) to humans, cats, and dogs. Nymphs and adults can transmit 364D rickettsiosis (Rickettsia phillipi) to humans, tularemia (Francisella tularensis) to humans, cats, and dogs, and bovine anaplasmosis to cattle. These ticks also have been implicated in cases of tick-bite paralysis in cattle, deer, and ponies.


no common infectious ticks in Alaska
Rocky Mountain Wood Tick
Brown Dog Tick
everywhere!
and in Hawaii !
Gulf Coast Tick

Other Less Known Ticks

Ixodes cookei **Packard**

Ixodes cookei, sometimes referred to as the "woodchuck tick", is found throughout the eastern half of the United States and Canada. It is a primarily a parasite of medium-sized mammals such as woodchucks, opossums, raccoons, skunks, and foxes. In a New York study, it was the second most abundant tick on medium-sized mammals behind *I. scapularis*. All stages of *I. cookei* will feed on humans, though reports in southern New England and New York are uncommon.

WOODCHUCK TICK

It appears to be a more frequent human parasite in northern New England and Ontario, Canada. After the American dog tick*, I. cookei* was the second most common tick removed from humans in Maine from 1989-1990 (*I. scapularis* was third). Lyme disease spirochetes have been detected in this tick, but laboratory studies suggest it is not a good vector for *B. burgdorferi*. However, *I. cookei* is the principal vector for Powassan virus, which can cause severe or fatal human encephalitis.

WINTER TICK

Winter Tick, *Dermacentor albipictus* (Packard)
The winter tick, *Dermacentor albipictus*, is a one-host tick found commonly on moose (*Alces alces*), elk (*Cervus elaphus*), and deer. Hunters will encounter this tick (as well as *I. scapularis*) on harvested deer, moose, and elk during the hunting season. Heavy tick infestations can cause anemia and other problems and death of the animal. Larval ticks infest animals in the fall and then develop into nymphs and adults without leaving the host. Engorged females will drop off the host animal in the spring. This tick is broadly distributed from Canada to Central America. This tick will occasionally feed on humans.

Western Blacklegged Tick, *Ixodes pacificus* Cooley and Kohls
Although outside the scope of this course, readers should note that the western blacklegged tick, *Ixodes pacificus*, is the principal vector for Lyme disease to humans in the western United States. It looks just like the blacklegged tick in the east and only a specialist could tell them apart.

WESTERN BLACKLEGGED TICK
LOOKS SIMILAR TO MANY OTHER HARD TICKS

It is found along the Pacific Coast in the western half of Washington and Oregon, almost all of California, and in parts of Utah, Arizona, and New Mexico. Infection rates with *B. burgdorferi* are generally low, 5-6% or less, because many of the immature *I. pacificus* ticks feed on the western fence lizard (*Sceloporus occidentalis*), a reservoir incompetent host for *B. burgdorferi* whose blood also contains a borreliacidal factor that destroys spirochetes in *I. pacificus* nymphs. Several rodents (mainly woodrats) and a nest dwelling tick, *I. spinipalpis*, maintain the enzootic cycle of Lyme disease in California and other western states.

***Carios (Ornithodoros) kelleyi* Cooley and Kohls**
This tick feeds on bats and is found in homes, bat colonies, and other areas where bats may be found. It may occasionally bite humans whose dwellings are infested by bats. Distributed throughout the U.S., records from the northeast include Pennsylvania, New York, and Connecticut.

Imported Ticks
Travelers abroad have found exotic ticks on themselves after returning to the United States. Other ticks may be imported on pets and other animals. Some of these ticks are potential vectors of pathogens of domestic livestock and introduction and establishment of these ticks would have serious consequences for the livestock industry. For humans, there are a number of bacterial and rickettsial pathogens and encephalitis and hemorrhagic fever viruses carried by ticks in Europe, Asia, Africa and Australia.

For example, cases of boutonneuse fever, also called Mediterranean spotted fever, have occurred in travelers returning to the U.S. Boutonneuse fever is distributed through Africa, countries around the Mediterranean, southern Europe, and India. Other spotted fever diseases are African tick-bite fever, Siberian tick typhus, and Queensland tick typhus.

Several tick-borne encephalitis viruses, as well as Lyme disease spirochetes, are transmitted by *Ixodes ricinus* ticks in the British Isles, central and Eastern Europe, and Russia and by *Ixodes persulcatus* from central Europe, Russia, parts of China, and Japan. The following ticks have been documented from traveler's returning to the northeast (destination, origin): *Amblyomma cajennense* (CT, Jamaica), *A. hebraeum* (CT, South Africa), *A. variegatum* (NY, Kenya), *Rhipicephalus simus* (CT, Kenya), *Dermacentor auratus* (ME, Nepal), and *Hyaloma marginatum* (CT, Greece). The Connecticut travelers returning from South Africa and Kenya were physician diagnosed with boutonneuse fever. Tick bite prevention measures should be taken by travelers to potentially tick infested areas abroad. Physicians should consider exotic tick-associated diseases in the differential diagnosis for a patient with a travel with a travel history outside the United States.

DERMCENTOR SPECIES

Louse Flies of Deer May Be Confused with Ticks
These flies are tick-like, blood-feeding parasitic flies (family Hippoboscidae), which may be confused with true ticks. The adult flies are dorsally flattened like a tick, with short legs. Several species are common parasites of white-tailed deer in the U.S. and are frequently seen by hunters or others in close association with deer. One species, *Lipoptena cervi* is known as the "deer ked" and was imported from Europe.

LOUSE FLY

It occasionally will bite humans. Other "deer keds" are native to the U.S. The female fly retains the larvae, nourishing them internally, and then lays mature larvae, which promptly pupate. The hippoboscid flies associated with deer have wings when they emerge, but lose them once they find a host.

Specific Tick Information Alphabetical Order
American Dog Tick *Dermacentor variabilis*

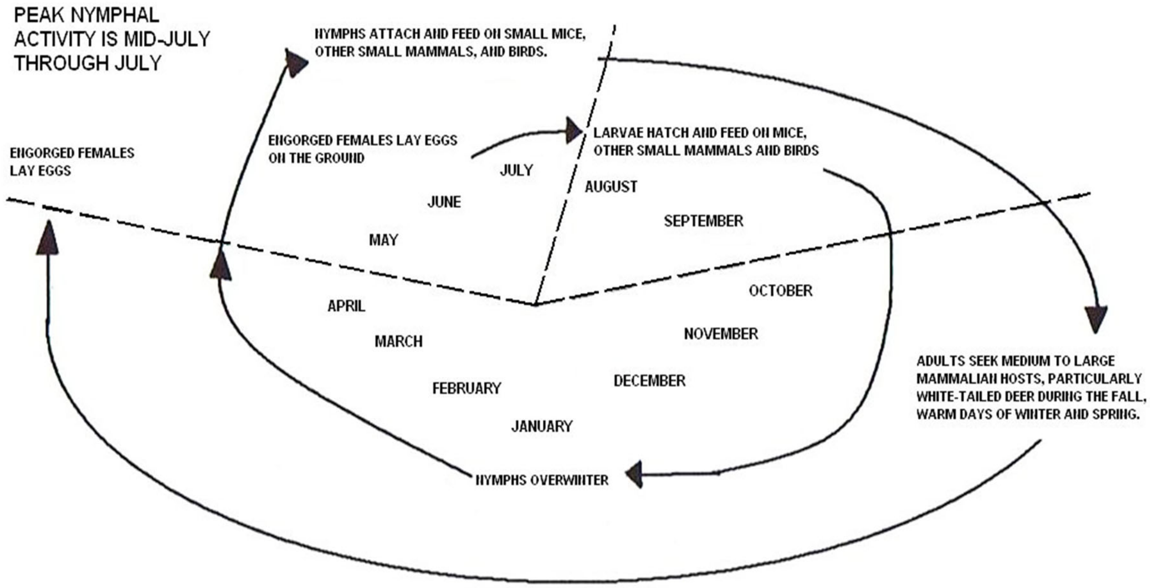
The American dog tick is found throughout the United States except in parts of the Rocky Mountain region. It also occurs in parts of Canada and Mexico. Its habitat includes wooded areas, abandoned fields, medium height grasses and shrubs between wetlands and woods, and sunny or open areas around woods.

AMERICAN DOG TICK

Larvae and nymphs feed primarily on small mammals (especially rodents); while the adults feed mainly on dogs, but will readily bite humans. The female lays 4,000-6,500 ellipsoidal eggs over a 14-32 day period and then dies. The eggs usually hatch in 36-57 days. Larvae usually engorge for 3-5 days, nymphs for 3-11 days, and adult females for 5-13 days. Unfed larvae can live up to 15 months, nymphs 20 months and adults 30 months or longer. Mating takes place on the host (Goddard 1989, Metcalf and Flint 1962). Adults are active from mid-April to early September. Nymphs are active from June to early September and larvae from late March through July. High light intensity and low relative humidity stimulate questing behavior (Newhouse 1983).

The American dog tick is found throughout the eastern United States. This tick is not known to spread Lyme disease, although it can transmit the causal agent of Rocky Mountain spotted fever. Only the adult tick is encountered by most people and pets. Adults become active about mid-April to early May and remain a nuisance until August. Adult dog ticks can be distinguished from adult *I. scapularis* by their larger size and the white markings on the upper body surface.

Female *I. scapularis* have a dark brown dorsal "shield" located behind the mouthparts, and when unengorged, have a reddish brown body. Male *I. scapularis* are smaller than the female and are completely dark brown. Female *I. scapularis* are fairly large when engorged with blood and, consequently, have been confused with the American dog tick during April, May and June when the adults of both tick species are active.This species is the primary vector of Rocky Mountain spotted fever in the eastern United States, and can also transmit Tularemia and cause tick paralysis.



AMERICAN DOG TICK

Research on control of ticks is ongoing. Workers have shown that by using registered insecticides at the proper time, tick contact may be greatly reduced. Treating with an insecticide does not guarantee, however, that no ticks will be present. People still need to protect themselves by dressing appropriately, using repellents when in potentially tick-infested areas and checking daily for the presence of ticks (and removing them if found).

Safety Tips for Pet Owners

- Consult your veterinarian about the best way to to protect your pets from fleas and ticks and whether pesticides are even needed.
- Do not apply to kittens or puppies unless the product label specifically allows this treatment. Pay attention to the age restrictions for puppies and kittens on the label.
- Follow any label prohibitions against use on weak, aged, medicated, sick, pregnant, or nursing pets, or on pets that have previously shown sensitivity to pesticide products. Apply only the amount indicated for the size of the animal being treated.
- If you use a spot-on product or any other pesticide on your pet, carefully read and follow the product label.
- If your pet experiences an adverse reaction, immediately bathe the pet with mild soap and rinse with large amounts of water.
- Keep the package with the product container (such as individual applicator tubes). Also keep the package after treatment in case adverse effects occur. You will want to have the instructions at hand, as well as contact information for the manufacturer.
- Monitor your pet for side effects or signs of sensitivity after applying the product, particularly when using the product on your pet for the first time. Do not apply spot-ons to pets known to be sensitive to pesticide products.
- Use extra care before use on weak, aged, medicated, sick, pregnant, or nursing pets, or on pets that have previously shown signs of sensitivity to pesticide products.
- Use flea and tick control products only on the animal specified by the product label - for example, dog products for dogs only and cat products for cats only.

Flea and Tick Control Tips
The following tips may help to prevent, reduce, or eliminate flea infestations:

- Consider keeping pets indoors.
- Flea combs are very effective tools in the suppression of adult fleas. They allow hair to pass through the tines but not the fleas, removing fleas as well as flea feces and dried blood. Focus combing on those parts of the pet where the most fleas congregate, usually the neck or tail area. When fleas are caught, deposit them in hot soapy water to kill them.
- Steam cleaning carpets may also help as the hot steam and soap can kill fleas in all stages of the life cycle. Pay particular attention to areas where pets sleep.
- Vacuuming on a daily basis to remove eggs, larvae and adults is the best method for initial control of a flea infestation. It is important to vacuum the following areas: carpets, cushioned furniture, cracks and crevices on floors, along baseboards and the basement.
- Wash all pet bedding and family bedding on which pets lie in hot, soapy water every two to three weeks. If an infestation is severe, discard old pet bedding and replace it with fresh, clean material.

The Centers for Disease Control and Prevention suggests the following ways to reduce ticks in your yard:

- Discourage deer. Removing plants that attract deer and constructing physical barriers may help discourage deer from entering your yard and bringing ticks with them.
- Modify your landscape to create Tick Safe Zones. To do this, keep play areas and playground equipment away from shrubs, bushes, and other vegetation. Also, regularly remove leaf litter and clear tall grasses and brush around homes, and place wood chips or gravel between lawns and wooded areas to keep ticks away from recreational areas.
- Provide a vegetation-free play area. Keep play areas and playground equipment away from away from shrubs, bushes, and other vegetation.
- Use a chemical control agent. Effective tick control chemicals are available for use by the homeowner, or they can be applied by a professional pest control expert, and even limited applications can greatly reduce the number of ticks. A single springtime application of acaricide can reduce the population of ticks that cause Lyme disease by 68-100%.

Biological Control of Ticks

- Ticks have relatively few natural enemies, but the use of predators, parasites, and pathogens has been examined for tick control. Tick predation is difficult to document and observations are sporadic. Most arthropod predators are non-specific, opportunistic feeders and probably have little impact on ticks. Anecdotal reports suggested that guinea-fowl or chickens may consume ticks and impact local tick abundance. However, there is no good evidence to support this and turkey foraging was not found to reduce the local density of adult ticks.

Chemical Treatments

Organophosphates (No Longer Used) There were two organophosphate insecticides commonly used for area-wide tick control, chlorpyrifos (i.e., Dursban) and diazinon. The EPA has cancelled the residential use and some agricultural uses of chlorpyrifos and has cancelled the registration of diazinon for lawn, garden, and other residential outdoor use. Residential applications accounted for nearly 75% of the use of diazinon. Products with these chemicals are no longer used for tick control.

Carbamates

Carbaryl (Sevin) is the carbamate used in the control of ticks. Carbaryl is a broad-spectrum compound used for a wide variety of pests on the lawn, on pets, and in the home. Carbaryl in animals is readily broken down and excreted. It does not appear to cause reproductive, birth, mutagenic, or carcinogenic effects under normal circumstances, but it is a suspected endocrine disrupter. Carbaryl is extremely toxic to bees and beneficial insects, is moderately toxic to fish, but is relatively nontoxic to birds.

Pyrethrins

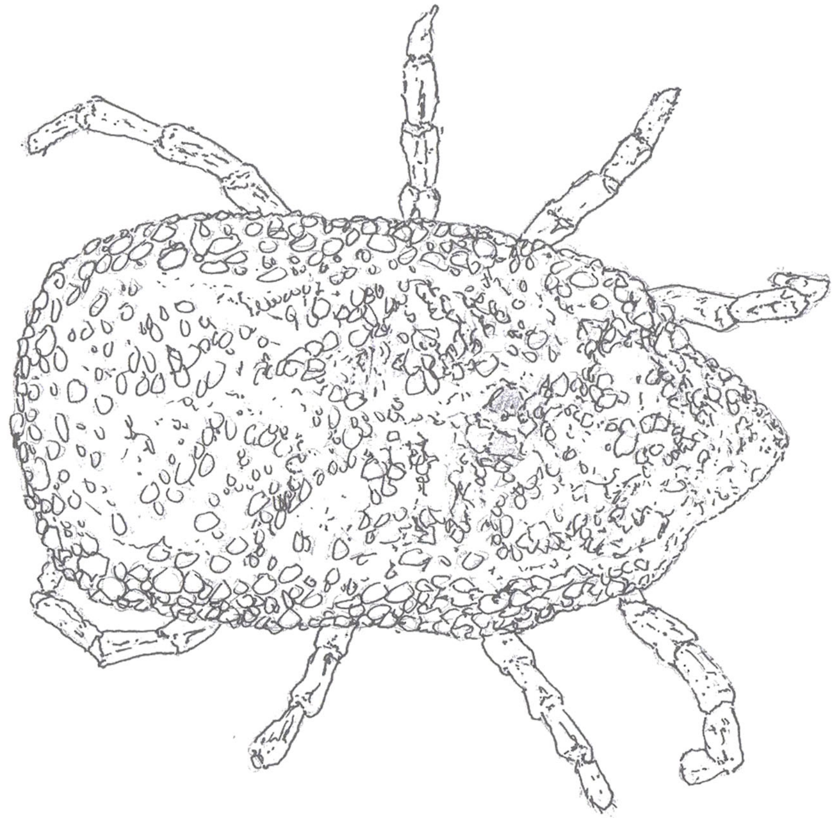
Pyrethrum is a natural insecticide extracted from certain chrysanthemum plants. Natural pyrethrins are a group of six compounds that form the insecticidal constituents of the natural pyrethrum, which is highly unstable in light and air. Natural pyrethrins are considered knockdown agents because they rapidly paralyze insects, but many insects can detoxify the compound and recover. Therefore, pyrethrins are sometimes combined with a synergist. A synergist is a compound that enhances the toxicity of an insecticide, but is not an insecticide itself. The most common synergist used with pyrethrin is piperonyl butoxide, which inhibits the enzymes that breakdown pyrethrin. Pyrethrins also may be combined with insecticidal soaps, spreader sticker agents, silicon dioxide (desiccant) and other agents to enhance the effectiveness of the product. Pyrethrins have little residual effect, being quickly broken down by exposure to light, moisture, and air.

Pyrethroids

Synthetic pyrethroids are derivatives of the natural compounds, chemically modified to increase toxicity and stability. Most of the chemicals used for area-wide tick control are pyrethroids. The pyrethroids are less volatile than the natural compounds and photostable, which provides some residual activity and greater insecticidal activity. Both pyrethrins and pyrethroids are highly toxic to fish and other aquatic organisms, but generally are much less toxic to mammals, birds and other wildlife.

Pyrethroids can be skin and eye irritants. Many concentrated pyrethroid formulations are restricted to commercial use by licensed applicators because of their potential impact on aquatic organisms. However, low concentration, ready-to-use products are available for homeowner use. Pyrethroids are particularly effective at rates 6-45 times less than the now cancelled organophosphate insecticides and the carbamate insecticide carbaryl. Synergized pyrethrin was more effective when combined with insecticidal soap or as part of a silicon dioxide (from diatomaceous earth) product. Silicon dioxide acts as a desiccant. Thorough coverage appears particularly important with pyrethrin and insecticidal soap products. With the exception of a desiccant, there is little residual activity. At least two applications may be required.

Bat Tick Carios (formerly Ornithodoros) kelleyi



BAT TICK

A bat tick, a type of soft tick, is brownish-gray or dirty gray in color with a granulated, i.e. warty, looking body. It is found in homes where bats roost in the upper floors of the buildings. Other soft-bodied ticks are associated with birds and poultry. In the absence of their normal hosts, these ticks may wander into parts of homes inhabited by people. While they can bite humans, this does not appear to be common. Fortunately, they are unable to reproduce on human blood and do not survive for long without their hosts.

Biology

Once hatched from the egg, bat ticks pass through a larval stage followed by six nymphal instars and adulthood. Development may be completed in three to five months, depending on temperature and host availability. In some ways, bat ticks behave more like bat bugs and bed bugs than hard ticks with which PMPs are familiar. Bat ticks are intermittent feeders — they take a blood meal several times per month and spend most of their time in harborages close to their hosts in bat roosts. Bat ticks thrive in dry environments and have been known to survive two years or more without feeding. Bat ticks are an indicator of a recent or previous infestation of bats in a structure.

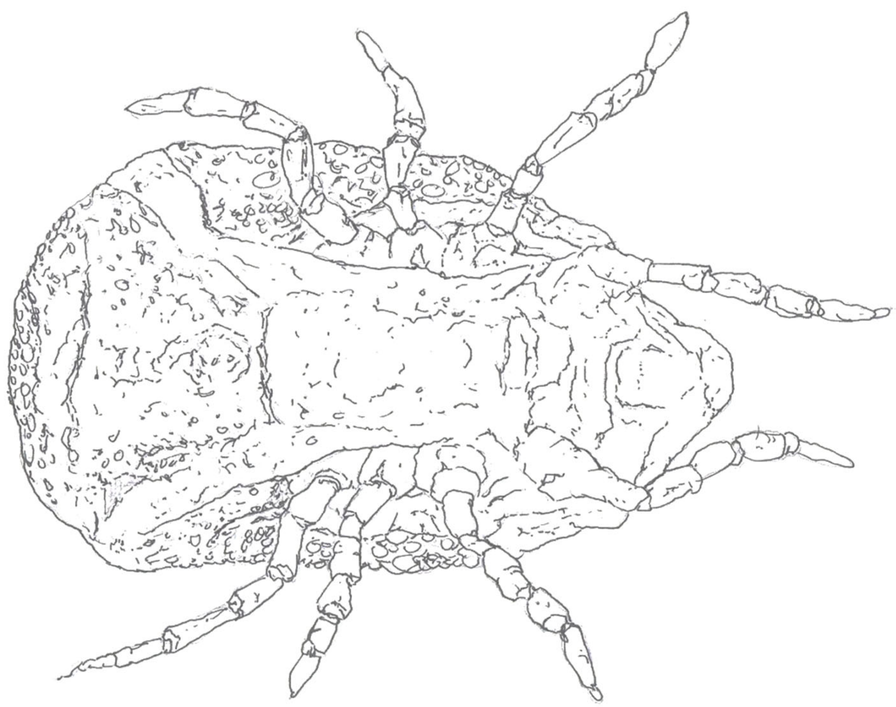
Customers who suspect or indicate they have been fed upon by a bat tick should be checked out by a physician who has been informed of the possibility of infection by one or more of the above-mentioned bacterial intracellular parasites. Focus attention to known and potential bat roost sites within buildings in which bat ticks have been found.

Perform a thorough crack and crevice treatment of the structural elements of previous bat roost sites using one or more residual insecticide formulations labeled for control of ticks. Those entering and applying pesticides in attics should wear personal protective equipment appropriate to confined spaces containing potentially hazardous airborne particulates, especially if accumulations of bat guano are present.

Use appropriate sealant or exclusion materials to close structural gaps suspected of being tick access points to living and workspaces. Place sticky monitors strategically along walls of indoor areas where bat ticks have been found and schedule follow-up inspections at biweekly or monthly intervals until the situation is resolved.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.



UNDERVIEW OF THE BAT TICK

Black Legged (Deer Tick) Ixodidae *Ixodes scapularis*

DEER TICK
LOOKS LIKE A BLACK LEGGED TICK, AMERICAN DOG TICK

Deer ticks are small, dark-colored ticks, sometimes called seed ticks. Deer ticks feed mostly on deer, cattle, and other large animals, but they will feed on people when they get a chance.

Habitat: These ticks are found along paths, trails, and roadways.

The deer tick is found in eastern North America including the New England, mid-Atlantic, and southeastern states, and the Midwestern states of Minnesota and Wisconsin. It has also been observed in Michigan, Iowa, Illinois, and Indiana. Deer ticks prefer heavily-forested or dense brushy areas and edge vegetation, but not open areas. An exception to this occurs in upstate New York where the species is found on well-maintained lawns in residential areas.

Larvae and nymphs feed primarily on small mammals (especially the white-footed mouse, other rodents, and insectivores), and also on birds, dogs, deer, and humans. Nymphs aggressively bite humans. Adults feed primarily on deer, but also attach to large mammals (foxes, raccoons, opossums, dogs) and humans.

Females lay up to 3000 eggs in soil and litter. Eggs take about 1 month to hatch. Larvae engorge for 2-3 days during the summer, detach, overwinter on the ground, and molt the following spring. Nymphs feed for 3-4 days, detach, and molt in early fall. Adult females engorge for 7-21 days, detach, oviposit the following spring, and die. The life cycle may range from 2-4 years and is regulated by host abundance and physiological mechanisms. Larvae are active from July through September, nymphs from May through August, and adults in the fall, winter, and early spring (October-May).

Distribution is associated with high humidity and mild mean winter temperatures. However, it is not restricted by winter temperatures, as areas of tick activity occur in Minnesota and Wisconsin. The requirement for high humidity restricts this tick from spreading to arid regions and high mountains where desiccation is a limiting factor (Lane et al. 1991). The deer tick is the major vector of Lyme disease in the northeastern and Midwestern United States. It is incriminated as the vector of human babesiosis in the northeastern United States.

Life Stages
The blacklegged or *"deer"* tick has three active stages; the larva, nymph, and adult (male and female). This tick feeds on a wide variety of mammals and birds. Each stage feeds only once and slowly; requiring several days to ingest the blood. Larvae of *I. scapularis* are rarely infected with *B. burgdorferi*. Larvae and nymphs typically become infected with Lyme disease bacteria when they feed on infected white-footed mice (*Peromyscus leucopus*), chipmunks (*Tamias striatus*), or certain species of birds. This mouse is the principal source (reservoir) of *B. burgdorferi* and the protozoan agent of human babesiosis in the east. Deer Ticks may inflict a painful bite.

Deer ticks can carry Lyme disease. Deer ticks are in the genus Ixodes, and there are several species of Ixodes that carry the Lyme disease bacteria in their systems. Lyme disease has become a notable tick-borne disease in some eastern states. It is an affliction that occurs in the summer months. This tick-transmitted bacterial disease is most likely to be contracted during the months of June through September, when young people and adults are outdoors. Dogs and horses in areas where the disease is common have developed joint problems that veterinarians believe to be caused by Lyme bacteria. Lyme disease can be treated successfully with antibiotics administered orally. See your doctor.

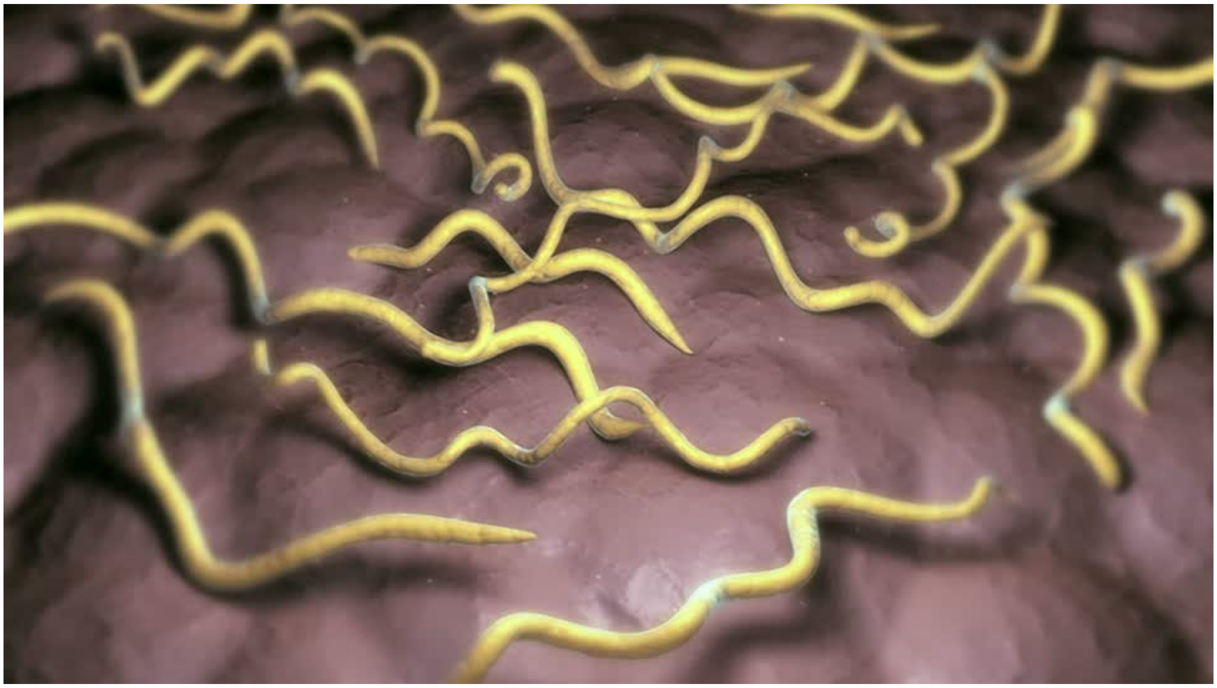
Interesting Fact: Lyme disease was first reported in Connecticut in 1975, and is named after the town of Lyme in which the disease was first observed.

The Deer Tick Life Cycle
The deer (or black-legged) tick in the East and the related western black-legged tick are the primary (and possibly the only) known transmitters of true Lyme disease in the United States. Both are hard-bodied ticks with a two-year life cycle. Like all species of ticks, deer ticks and their relatives require a blood meal to progress to each successive stage in their life cycles.

Stage 1: **Larva** - Eggs laid by an adult female deer tick in the spring hatch into larvae later in the summer. These larvae reach their peak activity in August.

No bigger than a newsprinted period, a larva will wait on the ground until a small mammal or bird brushes up against it. The larva then attaches itself to its host, begins feeding, and over a few days, engorges (swells up) with blood.

Lyme Disease Spirochete
If the host is already infected with the Lyme disease spirochete (a form of bacterium) from previous tick bites, the larva will likely become infected as well. In this way, infected hosts in the wild (primarily white-footed mice, which exist in large numbers in Lyme-endemic areas of the northeast and upper mid-west) serve as spirochete reservoirs, infecting ticks that feed upon them.

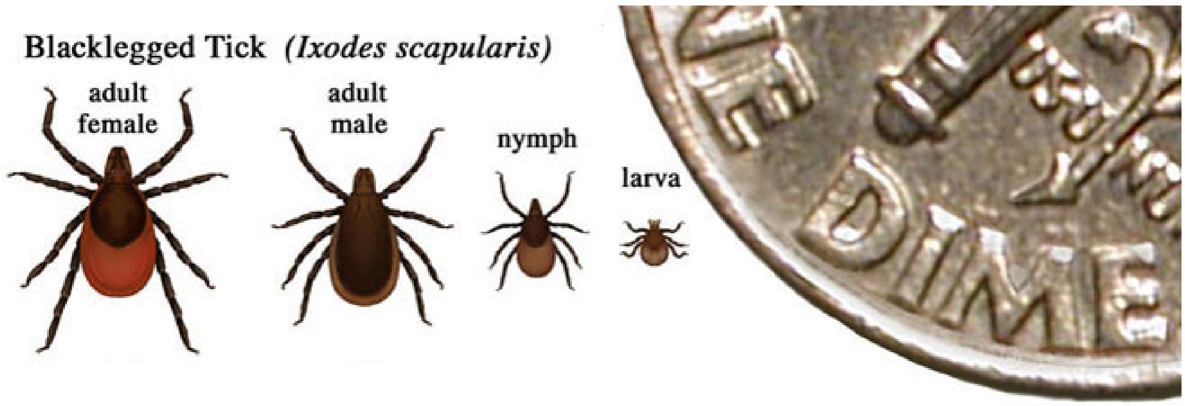


SPIROCHETE

Other mammals and ground-feeding birds may also serve as reservoirs. Because deer tick larvae are not born infected, they cannot transmit Lyme disease to their human hosts. Instead, "reservoir" hosts, as mentioned above, can infect the larvae. Having already fed, an infected larva will not seek another host, human or otherwise, until after it reaches the next stage in its life cycle. Therefore, larvae do not, in themselves, pose a threat to humans or their pets.

Stage 2: Nymph - Most larvae, after feeding, drop off their hosts and molt, or transform, into nymphs in the fall. The nymphs remain inactive throughout the winter and early spring. In May, nymphal activity begins. Host-seeking nymphs wait on vegetation near the ground for a small mammal or bird to approach. The nymph will then latch on to its host and feed for 4 or 5 days, engorging with blood and swelling to many times its original size.

If previously infected during its larval stage, the nymph may transmit the Lyme disease spirochete to its host. If not previously infected, the nymph may become infected if its host carries the Lyme disease spirochete from previous infectious tick bites. In highly endemic areas of the northeast, 25% of nymphs have been found to harbor the Lyme disease spirochete.



Too often, humans are the hosts that come into contact with infected nymphs during their peak spring activity (late May through July). Although the nymphs' preferred hosts are small mammals and birds, humans and their pets are suitable substitutes. Because nymphs are about the size of a poppy seed, they often go unnoticed until fully engorged, and are therefore responsible for the majority of human Lyme disease cases.

Stage 3: Adult - Once engorged, the nymph drops off its host into the leaf litter and molts into an adult. These adults actively seek new hosts throughout the fall, waiting up to 3 feet above the ground on stalks of grass or leaf tips to latch onto deer (its preferred host) or other larger mammals (including humans, dogs, cats, horses, and other domestic animals).

Peak activity for adult deer ticks occurs in late October and early November. Of adults sampled in highly endemic areas of the northeast, 50% have been found to carry the Lyme disease spirochete.

As winter closes in, adult ticks unsuccessful in finding hosts take cover under leaf litter or other surface vegetation, becoming inactive in temperatures below 40°F. Generally, winters in the northeast and upper mid-west are cold enough to keep adult ticks at bay until late February or early March (an exception was the warm winter of 1997-1998) when temperatures begin to rise. At this time, they resume the quest for hosts in a last-ditch effort to obtain a blood meal allowing them to mate and reproduce.

This second activity peak typically occurs in March and early April. Adult female ticks that attach to deer, whether in the fall or spring, feed for approximately one week. Males feed only intermittently.

Mating may take place on or off the host, and is required for the female's successful completion of the blood meal. The females then drop off the host, become gravid, lay their eggs underneath leaf litter in early spring, and die. Each female lays approximately 3,000 eggs. The eggs hatch later in the summer, beginning the two-year cycle anew.

Larval Ticks

- Generally from May through September, eggs hatch into larvae (plural).
- The larva (singular):
  - ✓ is the size of a period at end of sentence
  - ✓ initially does not carry diseases such as Lyme disease, human anaplasmosis, or babesioís
  - ✓ may pick up diseases during its first meal from a diseased host
- Larvae usually feed on white-footed mice or other small mammals.
- If the mouse is infected with disease-causing organisms, the larva will become infected and be able to transmit these organisms during its second or third feeding.
- The tick may also feed on a small mammal or bird that is not infected. These ticks cannot transmit disease in later feedings.
- After this feeding, the larvae molt into nymphs and become dormant until the following spring.

Nymphal Ticks

- In the spring and summer of the tick's second year, primarily from May through early July, the nymph becomes active and takes its second feeding from a mammal.
- If the tick is carrying disease agents from its first feeding in the larval stage, it can transmit them during this second feeding.
- If the nymph was not already infected, it can become infected if the second meal host is carrying disease agents.
- The nymph is about the size of a poppy seed. Nymph stage ticks often look like a speck of dirt or a freckle on a person's skin.

Adult Ticks

- ➢ In the fall of the second year, nymphs molt into adult ticks. Female adults are red or orange and larger than males.
- ➢ The adult female ticks feed and mate on large animals in the fall or early spring. The female lays her eggs, and then dies.
- ➢ If the ticks did not get a blood meal in the fall, they go dormant over winter and seek a meal in the spring. A frost does not kill blacklegged ticks. Adults may become active as soon as it is above freezing. They are occasionally spotted during a temporary thaw in the winter.
- ➢ As female ticks feed over the course of several days, their bodies slowly enlarge with blood (engorge). Adult females infected with disease agents as larvae or nymphs may transmit disease during this feeding.
- ➢ Male ticks attach, but do not feed or become engorged. Because the adult males do not take a blood meal, they do not transmit Lyme disease, human anaplasmosis, or babesiosis.

Feeding and blood meals

- Blacklegged ticks feed on blood by inserting their mouth parts into the skin.
- They are slow feeders and will feed for 3-5 days.
- If the blacklegged tick is infected, it must be attached for 24-48 hours before it transmits Lyme disease, and at least 12-24 hours to transmit human anaplasmosis.

Blacklegged Tick Habitat

BLACK LEGGED TICK
LOOKS LIKE OTHER HARD TICKS, DEER, DOG, ETC

Blacklegged Tick (formerly Deer Tick) Ixodes scapularis
Where do we find blacklegged ticks?

- Blacklegged ticks live in wooded, brushy areas that provide food and cover for white-footed mice, deer and other mammals.
- This habitat also provides the humidity ticks need to survive.
- Exposure to ticks may be greatest in the woods (especially along trails) and the fringe area between the woods and border.
- Blacklegged ticks search for a host from the tips of low-lying vegetation and shrubs, not from trees.
- Generally, ticks attach to a person or animal near ground level.
- Blacklegged ticks crawl; they do not jump or fly. They grab onto people or animals that brush against vegetation, and then they crawl upwards to find a place to bite.

Effectiveness in Controlling Ticks

- Blacklegged ticks and American dog ticks are readily killed by almost all ornamental and turf insecticides labeled for tick control. With the withdrawal of the organophosphate insecticides chlorpyrifos and diazinon from residential use (the U.S. Environmental Protection Agency has cancelled registration of these compounds for residential area-wide use), the synthetic pyrethroid insecticides are the most commonly used tick control agents.

- Pyrethroids are particularly effective at rates 6-45 times less than the now cancelled organophosphate insecticides and the carbamate insecticide carbaryl. Synergized pyrethrin was more effective when combined with insecticidal soap or as part of a silicon dioxide (from diatomaceous earth) product. Silicon dioxide acts as a desiccant. Thorough coverage appears particularly important with pyrethrin and insecticidal soap products. With the exception of a desiccant, there is little residual activity. At least two applications may be required.

- Liquids should be allowed to dry thoroughly before humans or pets reenter the area. Be especially careful using such materials near bodies of water -- do not contaminate water. Wear gloves and eye protection and do not eat or smoke when applying any pesticide. Wash skin and clothing after application, and always launder pesticide-contaminated clothing separately. CAREFULLY READ AND FOLLOW ALL PRODUCT DIRECTIONS.

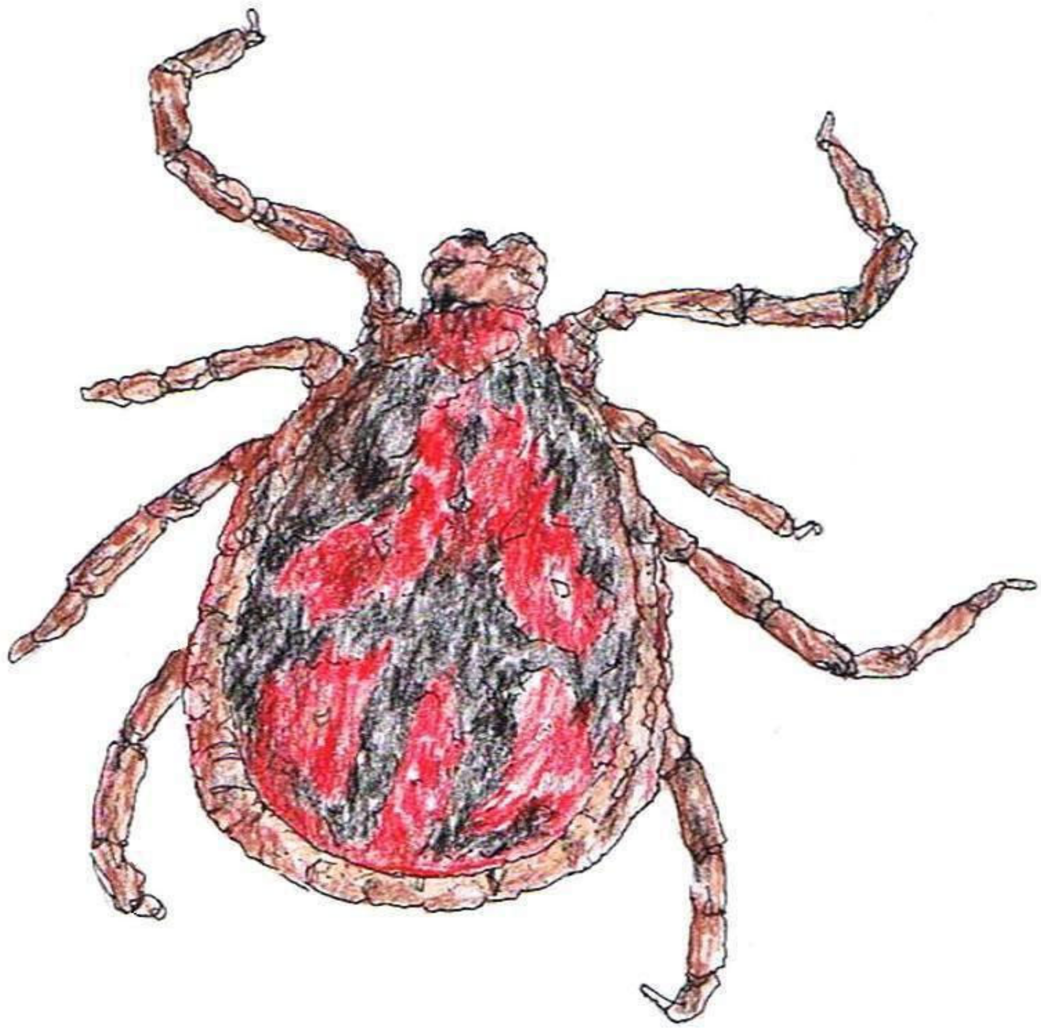
- Acaricides should only be used if avoidance of tick-infested areas is not an option and ticks are known to occur in the area to be treated. Since no tick control method is 100% effective, personal protection should always be practiced. Use of any chemical tick control method has limited or unpredictable success in reducing black-legged tick populations when used alone, particularly in residential settings. Consider using chemical control only in concert with habitat modification measures.

- Applications of either liquid acaricides, using high pressure hydraulic sprayers, or granular formulations, which can penetrate into dense foliage, directed against black-legged tick nymphs in late May to early June appear to have the greatest impact on the tick population, thereby reducing exposure to tick-borne diseases.

- Single applications consistently resulted in control of greater than 90% of nymphs. There is no need for repeated applications at regular intervals during the summer. However, the effectiveness of a single control attempt directed solely against adult or nymphal ticks in small areas will be temporary and limited only to that stage.

Brown Dog Tick *Rhipicephalus sanguineus*

The brown dog tick creates severe annoyance when it infests domestic pets and becomes established inside buildings. This is the most widely distributed tick in the U.S. and is characteristically a reddish-brown species that attacks dogs and other mammals, but rarely humans. It is not known to transmit human diseases. It most often attaches to the ears and between the toes of dogs. The engorged female ticks, sometimes about ½ inch long, are particularly noticeable as they crawl on walls, window frames, or around baseboards and cracks looking for protected areas in which to deposit their 1,000 to 3,000 eggs.



BROWN DOG TICK

The entire life cycle can be completed in less than two months. Homes and yards can become heavily infested after the passing of a single dog that drops an engorged female tick with thousands of eggs, eventually reaching a high density in the resident dogs' sleeping areas. This tick does not survive outside in cold climates.

Hosts

In the US, the brown dog tick prefers to feed on dogs in all stages. However, it will feed on other mammals, including domestic animals and humans. This is most likely to occur if it can't find a dog nearby, so beware of trying to control the tick by removing the dogs! Elsewhere in the world, it is more frequently found feeding on other mammals. This difference in host preference is not completely understood, but is probably related to the animals available and differences in the populations from the original introductions into new areas. In the southeastern US, it has been reported occasionally from rodents and deer, but most collections are from dogs and (much less commonly) humans.

Life Cycle

Ixodid ticks require three blood meals to complete development; once each as a larva, nymph and adult. The brown dog tick is a 3-host tick; this indicates that it leaves the host to develop and molt between the larval, nymphal and adult stages. Each stage must locate a host; in a domestic environment this may result in feeding on the same dog (if there is only one or a few dogs present), but there is an opportunity for the same tick to feed on three different hosts. A fully blood-fed female brown dog tick can lay up to 5000 eggs; the number of eggs laid depends on the size of the tick and the amount of blood she ingested. The length of time each stage feeds, and the time required for development and molting, are very dependent on temperature. Feeding and development times are generally faster at warmer temperatures. Survival is generally higher at cooler temperatures and higher relative humidity, but these ticks are tolerant of a wide range in conditions.

An adult female will feed on the host for around one week, then drop off the host and find a secluded place for egg development. Cracks and crevices in houses, garages and dog runs are ideal locations. She will start laying as soon as four days after she completes feeding and drops off the host, and can continue to lay for as long as 15 days. As she lays the eggs, she passes them over her porose areas (specialized areas on the back of the basis capituli), to coat them in secretions which protect the eggs from drying out. After she finishes laying her eggs, she dies. The larvae hatch two to five weeks later, and begin to quest, or look for a host. All stages of this tick prefer dogs, although they will feed on other mammals. Larvae feed for three to seven days, and then take about two weeks to develop into nymphs.

The nymphs then feed for five to 10 days and again take about two weeks to develop into adults. As adults, both males and females will attach to hosts and feed, although the males only feed for short periods. The overall cycle can be completed in just over two months, but frequently will take longer if there are few hosts available or in cold temperatures. Ticks are notoriously long-lived, and can live as long as three to five months in each stage without feeding.

Acaricide Selection

Many acaricides available for tick control can be purchased and applied by the general public. READ AND FOLLOW ALL DIRECTIONS ON THE LABEL. Alternative acaricides include soaps and desiccants. Specific acaricides, formulations, and methods of application may be restricted to certain target areas. Users are cautioned to carefully read the acaricide labeling to ensure that the proposed application is not in violation of federal and State pesticide control laws. Contact your Cooperative Extension, your County Agricultural Agent, or pesticide dealer for recommendations.

Pesticide Use
Insecticides, or as termed for ticks, acaricides, are the most effective way to reduce ticks, particularly when combined with the landscaping changes to decrease tick habitat. Acaricides provide consistent control, are relatively easy to apply, and are relatively inexpensive. Only small amounts of an acaricide applied at the right time of year are necessary. Chemical intervention should focus on early control of nymphal stage in May or early June. Summer and fall applications target mostly adult ticks. Targeting lawn and woodland edges and perimeter areas near tick “hot-spots” or along the “tick zone” can minimize exposure.

Some general points to consider if you spray for ticks:

- Applications can be made by the homeowner or by a commercial applicator.
- A single application of most ornamental-turf insecticides will provide 85-90% or better control with some residual activity so multiple applications are rarely necessary. Some organic pesticide products are less effective, breakdown rapidly, and multiple applications may be required.

Research has demonstrated the effectiveness of properly timed acaricide applications. If ticks are present, treat edge areas of the property where turf grass and woods meet) plus 12 feet into the woods to create a protective barrier. Shady areas of the lawn adjacent to the woods and areas landscaped with shrubs and ground covers such as pachysandra may also be treated.

Effectiveness in Controlling Ticks
Blacklegged ticks and American dog ticks are readily killed by almost all ornamental and turf insecticides labeled for tick control. With the withdrawal of the organophosphate insecticides chlorpyrifos and diazinon from residential use (the U.S. Environmental Protection Agency has cancelled registration of these compounds for residential area-wide use), the synthetic pyrethroid insecticides are the most commonly used tick control agents.

Pyrethroids are particularly effective at rates 6-45 times less than the now cancelled organophosphate insecticides and the carbamate insecticide carbaryl. Synergized pyrethrin was more effective when combined with insecticidal soap or as part of a silicon dioxide (from diatomaceous earth) product. Silicon dioxide acts as a desiccant. Thorough coverage appears particularly important with pyrethrin and insecticidal soap products. With the exception of a desiccant, there is little residual activity. At least two applications may be required. Liquids should be allowed to dry thoroughly before humans or pets reenter the area. Be especially careful using such materials near bodies of water -- do not contaminate water. Wear gloves and eye protection and do not eat or smoke when applying any pesticide. Wash skin and clothing after application, and always launder pesticide-contaminated clothing separately. CAREFULLY READ AND FOLLOW ALL PRODUCT DIRECTIONS.

Acaricides should only be used if avoidance of tick-infested areas is not an option and ticks are known to occur in the area to be treated. Since no tick control method is 100% effective, personal protection should always be practiced. Use of any chemical tick control method has limited or unpredictable success in reducing black-legged tick populations when used alone, particularly in residential settings. Consider using chemical control only in concert with habitat modification measures. Applications of either liquid acaricides, using high pressure hydraulic sprayers, or granular formulations, which can penetrate into dense foliage, directed against black-legged tick nymphs in late May to early June appear to have the greatest impact on the tick population, thereby reducing exposure to tick-borne diseases.

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BROWN DOG TICK

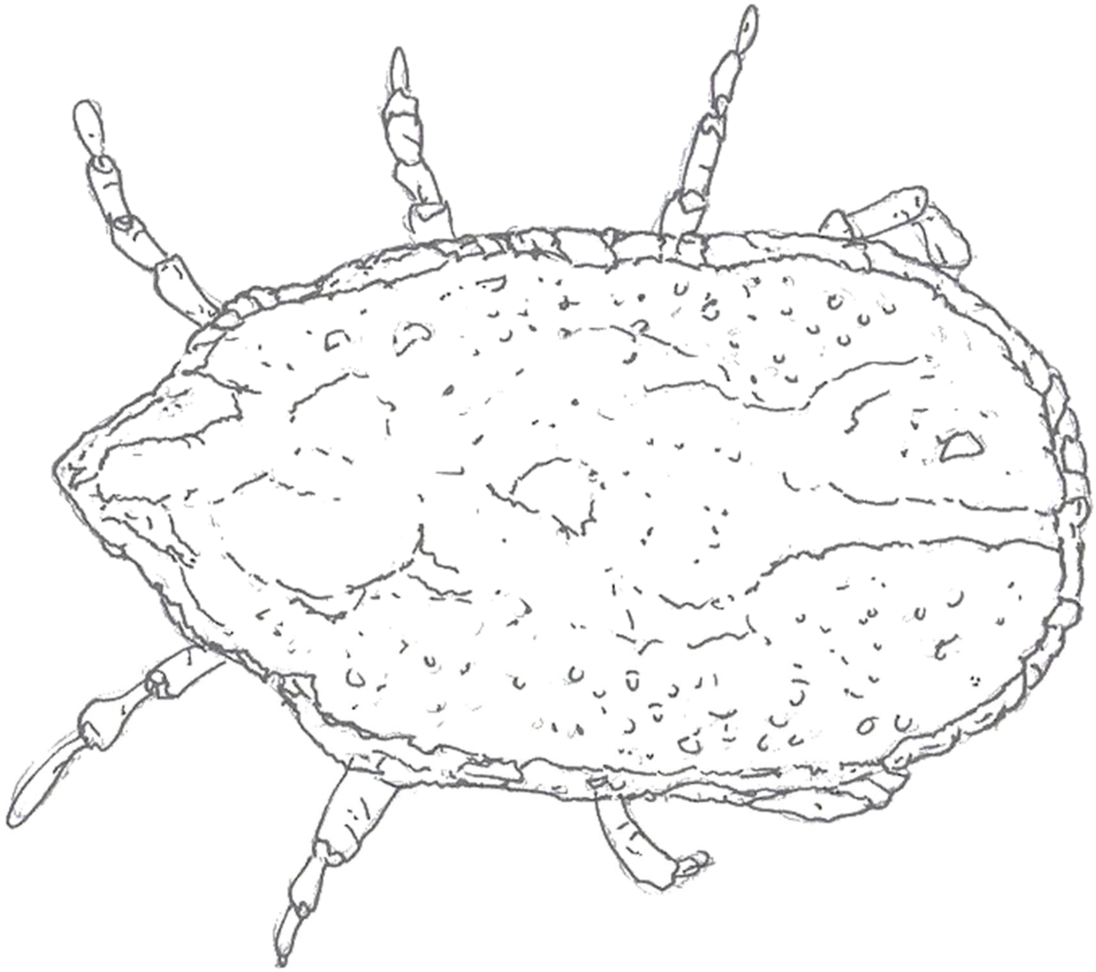
Summary

Rhipicephalus sanguineus, the brown dog tick, occurs throughout the entire region below 50° N latitude. This tick feeds primarily on dogs but also on camels, horses, sheep, gerbils and, occasionally, humans. It is a three-host tick, with larval and nymphal stages preferring to feed on rats or dogs, while adults feed primarily on dogs, and opportunistically on humans. Larvae and nymphs of R. sanguineus spend 3 to 6 days feeding on a host, then drop off to molt.

Immature stages prefer long hair at the back of the neck, while adults are commonly found in the ears and between the toes of dogs. After mating on the host animal, the female feeds for 7 to 15 days, and then drops off the host to lay eggs. Females lay hundreds of eggs, generally in the dens of host animals, usually canines, or in the cracks and crevices of infested houses. Eggs may require 10 to 20 days to hatch.

Adult R. sanguineus are passive in their host-questing activity, rarely moving more than 2 m to find a host. This species requires a humid microhabitat, which it can often find in the dens of its hosts.

Fowl Tick *Argas persicus* - Soft Tick



FOWL TICK

This soft tick feeds rapidly at night and subsequently oviposits in cracks and crevices. The tick has two or three nymphal stages before molting to the adult stage. Like the relapsing fever tick, this tick may live for months or years without a blood meal. *Argus persicus* readily attacks humans but does not transmit human disease. It is a vector of fowl spirochaetosis.

The fowl tick also is known as the *"blue-bug"*. It is a parasite of poultry, with sucking mouthparts concealed on the underside of the body. It is a member of the soft tick family and, unlike hard ticks, has no hard plate over the body. Mature fowl ticks are 1/4 to 3/8 inch long.

Elimination of Dursban Pesticide for Nearly all Household Uses

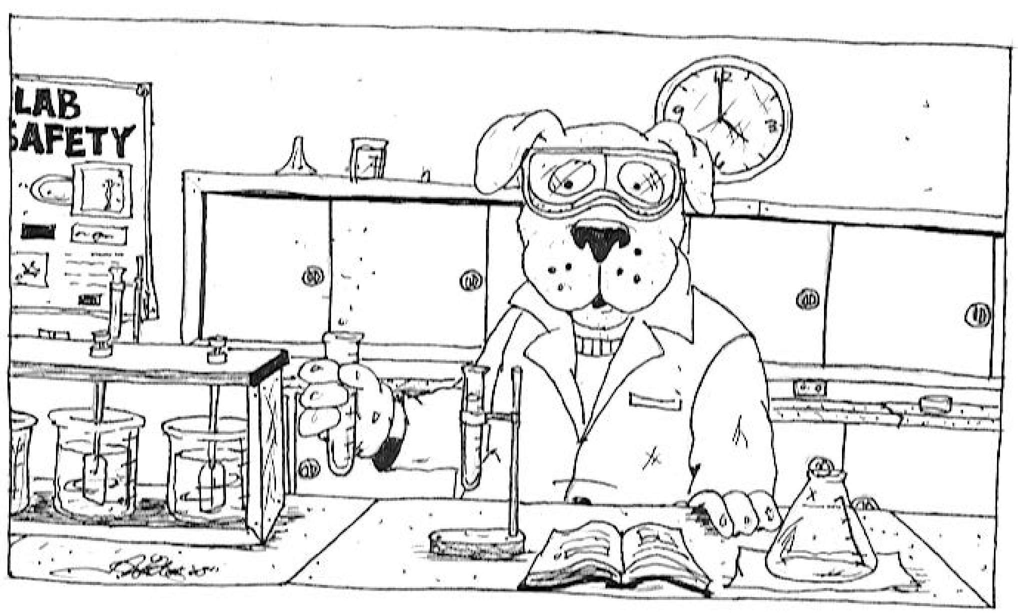
- To protect children and public health, the EPA and the manufacturer of the pesticide Dursban have agreed to eliminate its use for nearly all household purposes and to move to significantly reduce residues of it on several foods regularly eaten by children.

- Dursban, also known as chlorpyrifos, is the most widely used household pesticide produced in the U.S. It is an ingredient used for a broad range of lawn and home insecticide products, for agricultural purposes, and for termite treatment.

- Under the agreement, production will cease and there will be a phase-out of all home, lawn and garden uses, and the vast termite control uses.

- ***"Chlorpyrifos is part of a class of older, riskier pesticides, some going back 50 years. Exposure to these kinds of pesticides can cause neurological effects. Now that we have completed the most extensive evaluation ever conducted on the potential health hazards from a pesticide, it is clear that the time has come to take action to protect our children from exposure to this chemical,"*** said EPA Administrator Carol M. Browner.

- The agreement mandates that all uses will be phased out this year in areas where children could be exposed, including schools, daycare centers, parks, recreation areas, hospitals, nursing homes, stores and malls. In addition, the agreement calls for canceling or significantly lowering allowable residues for several foods regularly eaten by children, such as tomatoes, apples, and grapes.



Lone Star Tick *Amblyomma americanum*

This tick species occurs from central Texas east to the Atlantic coast and north to Iowa and New York; it has also been reported in northern Mexico. The Lone Star tick is found in wooded areas, especially where there is dense underbrush, but it is also found in scrub, meadow margins, hedge rows, cane breaks, and marginal vegetation along rivers and streams. The immatures and adults feed on a wide variety of mammals (including humans) and ground-feeding birds.

Each female produces 3,000-8,000 eggs, which are deposited under leaf and soil litter in middle to late spring. Incubation may take 30 days or longer, depending on temperature. The newly hatched six-legged immatures, also known as larvae or seed ticks, feed for 3 to 7 days on a host. After full engorgement the larvae drop from the host into vegetation and shed their skins 9-27 days later. The eight-legged immatures that emerge are called nymphs.

LONE STAR TICK

Image: Adult female *Amblyomma americanum* tick.
Note the characteristic "*Lone star*." Nasty creature.

These attach to a second host and feed for up to 38 days; the nymphs then detach and rest for 13-46 days before they shed their skins to become adults. Adults attach to a third host, feed for 6-24 days, and detach. Oviposition occurs 7-16 days after the last blood meal. Larvae may survive for 2-9 months, and nymphs and adults for 4-15 months each (Goddard 1989); the life cycle may take up to 2 years to complete. Lone Star tick nymphs can move very quickly and may cover a person's legs or arms in less than five minutes. This is a good behavioral characteristic to note to aid in identification of this tick species.

Earlier in the summer, female ticks deposit masses of several thousand eggs on the ground. Anyone unfortunate enough to pass through such a site can easily pick up dozens of larvae. These tiny, 6-legged creatures, also called "*seed ticks*", are most active between July and October.

During this time, the larvae climb low vegetation and wait with outstretched front legs to latch on to passing animals or humans. Once "*on board*", they crawl around to find a suitable place to attach and feed. The painful feeding site can be irritating for days after the tick has detached or been removed.

Adults and nymphs are active from early spring through midsummer, while larvae are active mainly from late summer to early fall. Low humidities and high daytime temperatures restrict the occurrence and activity of these ticks (Goddard 1989). Lone Star ticks transmit Tularemia to humans.

Lone Star ticks infected with the agents of Rocky Mountain spotted fever and Lyme disease occur in nature, but the species does not appear to be epidemiologically important in the transmission of these diseases (see Goddard 1989).

Vector
Amblyomma americanum ticks are found through the southeast and south-central states. Their life cycle and ecologic requirements are similar to *Ixodes* ticks, with minor exceptions not described here. All three life stages of *A. americanum* aggressively bite people in the southern U.S. Research indicates that live spirochetes are observed in only 1-3% of *A. americanum*.

The Bacterium
Even though spirochetes have been seen in *A. americanum* ticks by microscopy, attempts to culture it in the laboratory have consistently failed. Modified BSK (Barbour-Stoenner-Kelly) is the best medium for cultivating the Lyme disease spirochete, *B. burgdorferi*, but is apparently not suitable for cultivating the spirochete found in *A. americanum*. However, a spirochete has been detected in *A. americanum* by DNA analysis and was given the name *Borrelia lonestari*.

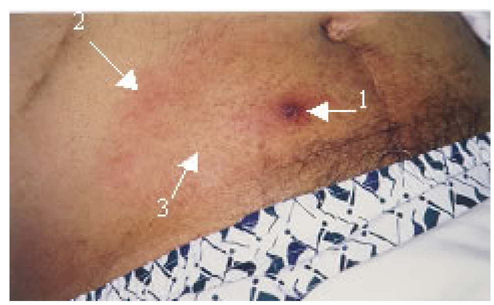


Image: Patient with a classic erythema migrans; 1) site of tick bite, 2) red, radial, expanding edge of rash. 3) central clearing.

Symptoms and Diagnosis
Persons living or traveling in southeast or south-central states who develop a red, expanding rash with central clearing (the rash of Lyme disease, erythema migrans) following the bite of the lone star tick, *A. americanum*, should see their physician. The Centers for Disease Control and Prevention is interested in obtaining samples from such patients under an Institutional Review Board-approved investigational protocol.

Some Brand or Common Pesticide names

Chemical	Some brand or common names*	Chemical type and usage
Bifenthrin	Talstar® Ortho® product	Pyrethroid insecticide. Available as liquid and granular formulations. Products available for homeowner use and commercial applicators.
Carbaryl	Sevin®	Carbamate insecticide. A common garden insecticide for homeowner use, some products are for commercial use only.
Cyfluthrin	Tempo® Powerforce	Pyrethroid insecticide. Available for commercial and homeowner use with concentrates and ready to spray (RTS) products.
Deltramethrin	Suspend® DeltaGard®	A pyrethroid insecticide for commercial applicators.
lambda-cyhalothrin	Scimitar® Demand®	A pyrethroid insecticide for commercial applicators.
Permethrin	Astro® Ortho® products Bonide® products Tengard® SFR Others	Pyrethroid insecticide. There are concentrates and ready to spray (RTS) products. Most are for homeowner use, a few are for commercial use only.
Pyrethrin	Pyrenone® Kicker® Organic Solutions All Crop Commercial & Agricultural Multipurpose Insecticide®	Natural pyrethrins with the synergist piperonyl butoxide (PBO) or insecticidal soap provide limited tick control. A combination of pyrethrin and PBO with either insecticidal soap or silicon dioxide (from diatomaceous earth) was found effective against ticks in one trial.

Biological Control of Ticks
Ticks have relatively few natural enemies, but the use of predators, parasites, and pathogens has been examined for tick control. Tick predation is difficult to document and observations are sporadic. Most arthropod predators are non-specific, opportunistic feeders and probably have little impact on ticks. Anecdotal reports suggested that guinea-fowl or chickens may consume ticks and impact local tick abundance. However, there is no good evidence to support this and turkey foraging was not found to reduce the local density of adult ticks.

Carbamates
Carbaryl (Sevin) is the carbamate used in the control of ticks. Carbaryl is a broad-spectrum compound used for a wide variety of pests on the lawn, on pets, and in the home. Carbaryl in animals is readily broken down and excreted. It does not appear to cause reproductive, birth, mutagenic, or carcinogenic effects under normal circumstances, but it is a suspected endocrine disrupter. Carbaryl is extremely toxic to bees and beneficial insects, is moderately toxic to fish, but is relatively nontoxic to birds.

Organophosphates (No Longer Used) There were two organophosphate insecticides commonly used for area-wide tick control, chlorpyrifos (i.e., Dursban) and diazinon. The EPA has cancelled the residential use and some agricultural uses of chlorpyrifos and has cancelled the registration of diazinon for lawn, garden, and other residential outdoor use. Residential applications accounted for nearly 75% of the use of diazinon. Products with these chemicals are no longer used for tick control.

Pyrethrins

Pyrethrum is a natural insecticide extracted from certain chrysanthemum plants. Natural pyrethrins are a group of six compounds that form the insecticidal constituents of the natural pyrethrum, which is highly unstable in light and air. Natural pyrethrins are considered knockdown agents because they rapidly paralyze insects, but many insects can detoxify the compound and recover. Therefore, pyrethrins are sometimes combined with a synergist. A synergist is a compound that enhances the toxicity of an insecticide, but is not an insecticide itself. The most common synergist used with pyrethrin is piperonyl butoxide, which inhibits the enzymes that breakdown pyrethrin. Pyrethrins also may be combined with insecticidal soaps, spreader sticker agents, silicon dioxide (desiccant) and other agents to enhance the effectiveness of the product. Pyrethrins have little residual effect, being quickly broken down by exposure to light, moisture, and air.

Pyrethroids

Synthetic pyrethroids are derivatives of the natural compounds, chemically modified to increase toxicity and stability. Most of the chemicals used for area-wide tick control are pyrethroids. The pyrethroids are less volatile than the natural compounds and photostable, which provides some residual activity and greater insecticidal activity. Both pyrethrins and pyrethroids are highly toxic to fish and other aquatic organisms, but generally are much less toxic to mammals, birds and other wildlife. Pyrethroids can be skin and eye irritants. Many concentrated pyrethroid formulations are restricted to commercial use by licensed applicators because of their potential impact on aquatic organisms. However, low concentration, ready-to-use products are available for homeowner use. Pyrethroids are particularly effective at rates 6-45 times less than the now cancelled organophosphate insecticides and the carbamate insecticide carbaryl. Synergized pyrethrin was more effective when combined with insecticidal soap or as part of a silicon dioxide (from diatomaceous earth) product. Silicon dioxide acts as a desiccant. Thorough coverage appears particularly important with pyrethrin and insecticidal soap products. With the exception of a desiccant, there is little residual activity. At least two applications may be required.

Diagnostic Laboratory Tick Identification

Ticks can be submitted to the Insect Diagnostic Laboratory at Cornell University for identification. A $35.00 identification fee applies per sample. Please do not mail ticks in in alcohol due to mail regulations.

The Diagnostic Laboratory does not test ticks for any disease agents. If you want the tick tested please check with your physician or local county health office for the names of laboratories performing tick-testing services. Be sure to ask for information regarding price, response time, and proper procedure for mailing. Some laboratories perform tests only on living or recently dead ticks, while other laboratories test ticks preserved in alcohol.

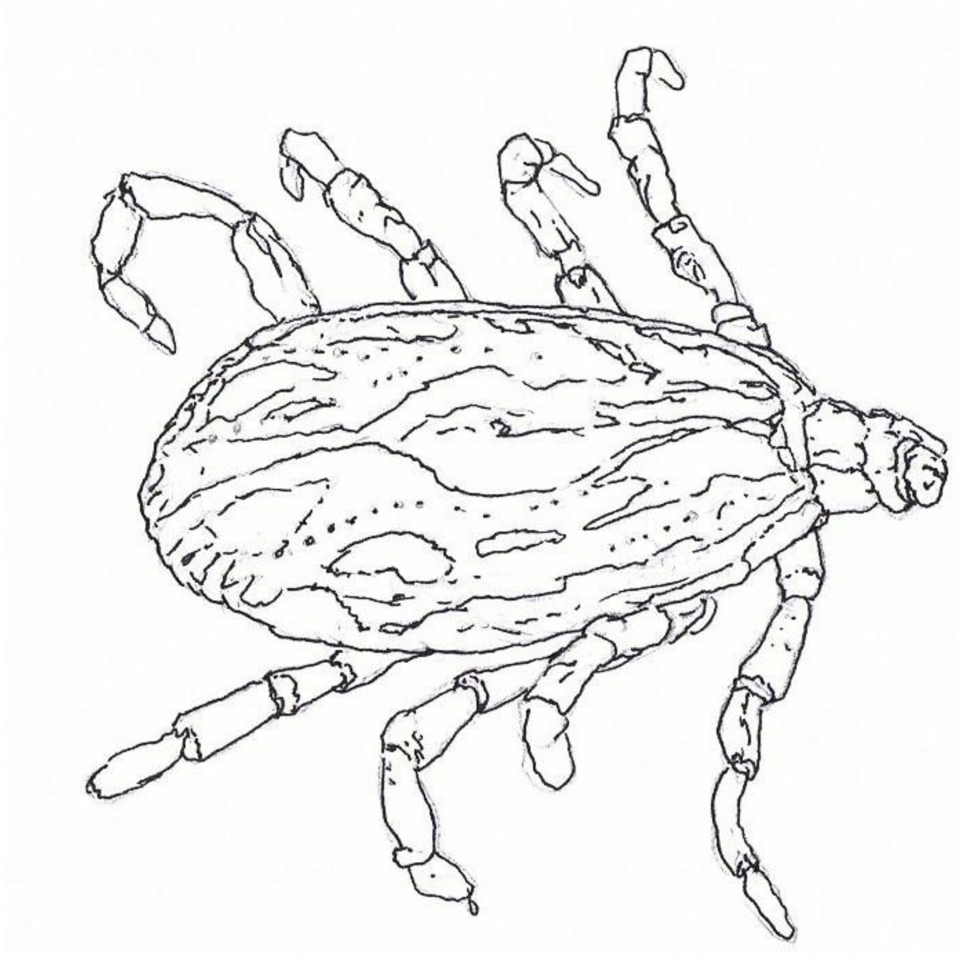
Geographic Distribution
For each species of tick, the geographic distribution, habitat, hosts, life cycle, seasonal abundance, responses to environmental factors, as well as direct and indirect medical effects are described. Information concerning the removal of ticks, outbreaks of tick-borne diseases, and natural enemies are presented. Tick management approaches including methods of population monitoring, decision-making, and intervention are described. All of these tick species are attracted to carbon dioxide and generally prefer low light intensity, high relative humidity, and protection from constant breezes. Temperature and humidity are the two most important environmental factors affecting survival.

2017 Changes to EPA's Farm Worker Protection Standard

In late 2015 the Environmental Protection Agency issued the long awaited revision to the Worker Protection Standard (WPS). This law it is now technically active and it will be enforced. Please keep in mind that the WPS covers both restricted use AND general use pesticides. This course is not for worker and/or handler training. Always follow the label and your State Pesticide Agency rules.

This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

Pacific Coast Tick *Dermacentor occidentalis*



PACIFIC TICK

The Pacific Coast Tick is a three host tick which commonly feeds on rodents, especially squirrels, as sub-adults, and on cattle, horses, deer, and humans as adults. This is one of the most widely distributed ticks in California. It is found throughout the state except for the very dry regions of the central valley and the southeastern desert region. The only other areas it has been collected in are Oregon and Baja, Mexico (Furman and Loomis 1984).

Diagnostic Laboratory Tick Identification

Ticks can be submitted to the Insect Diagnostic Laboratory at Cornell University for identification. A $50.00 identification fee applies per sample. Please do not mail ticks in in alcohol due to mail regulations.

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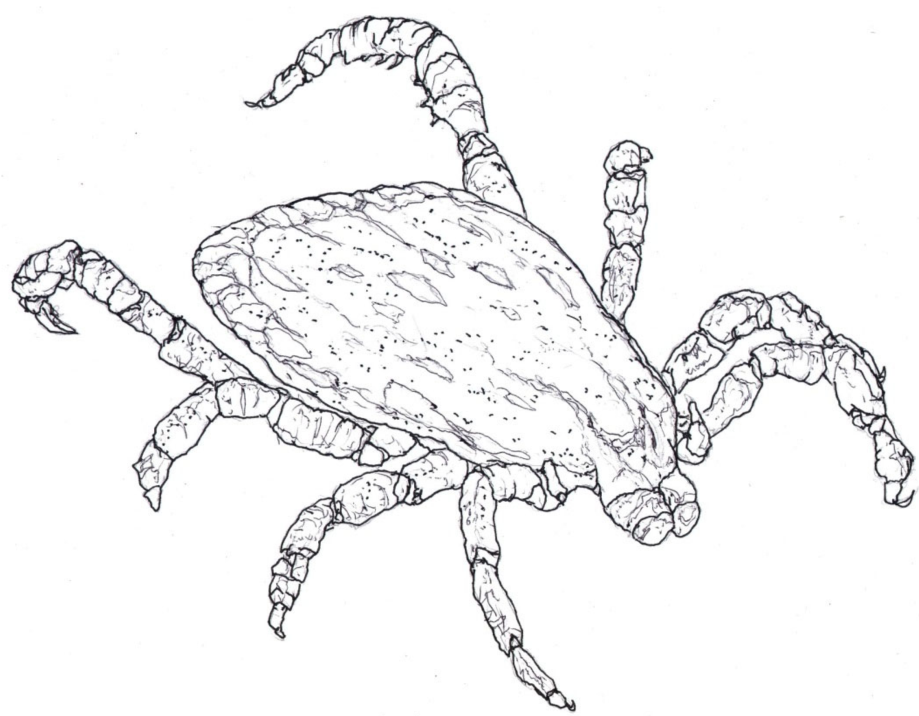
Acaricides

Acaricides should only be used if avoidance of tick-infested areas is not an option and ticks are known to occur in the area to be treated. Since no tick control method is 100% effective, personal protection should always be practiced. Use of any chemical tick control method has limited or unpredictable success in reducing black-legged tick populations when used alone, particularly in residential settings. Consider using chemical control only in concert with habitat modification measures. Applications of either liquid acaricides, using high pressure hydraulic sprayers, or granular formulations, which can penetrate into dense foliage, directed against tick nymphs in late May to early June appear to have the greatest impact on the tick population, thereby reducing exposure to tick-borne diseases. Single applications consistently resulted in control of greater than 90% of nymphs. There is no need for repeated applications at regular intervals during the summer. However, the effectiveness of a single control attempt directed solely against adult or nymphal ticks in small areas will be temporary and limited only to that stage.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

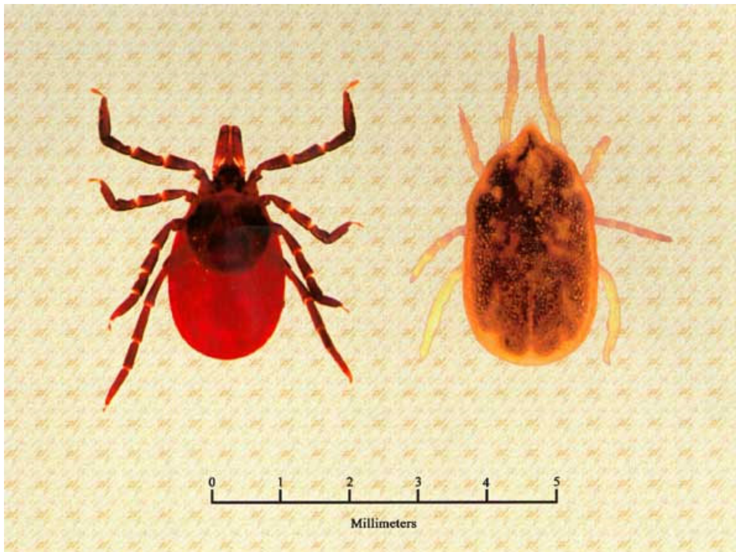
NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.



PACIFIC TICK

Relapsing Fever Tick *Ornithodorus* spp.

This is the most important genus of soft ticks from a medical standpoint. Relapsing fever ticks are seldom seen by the average person because they are nest ticks and can survive starvation for months or even years. Bitten people may contract relapsing fever.



Dorsal view of a female *Ixodes scapularis* (family Ixodidae, hard ticks), a vector of *Borrelia burgdorferi* (left), and a female *Ornithodoros hermsi* (family Argasidae, soft ticks), the vector of *B. hermsii* (right).

ORNITHODORUS SPP.

These ticks are the vector of relapsing fever, which has created serious health problems at the Grand Canyon. The relapsing-fever tick, *Ornithodorus hermsi*, is sand-colored before feeding, but turns grayish-blue after it feeds. The adult female is about 1/4" long.

Relapsing Fever
What is Relapsing Fever?
Relapsing fever is an illness caused by a bacteria, a spirochete, which is carried by wild rodents and ticks. The ticks can remain infective for life and pass the infection on to the next generation.
Who gets Relapsing Fever?

Anyone can get relapsing fever that is bitten by an infected tick. Most cases in North America are reported in the western U.S. and Canada.

How is Relapsing Fever spread?
People get relapsing fever from the bite of an infected tick. There is no evidence of natural person-to-person transmission.

What are the symptoms of Relapsing Fever?
The disease causes a fever which lasts from 2-9 days and alternates with a period of 2-4 days without fever, after which fever returns. The number of relapses varies from 1-10 or more. The first onset of fever is often accompanied by a rash. Relapsing fever can be fatal if not treated.

How soon do symptoms usually appear?
The symptoms generally begin 8 days after the tick bite, but can appear as early as five and as late as 15 days after a tick bite.

Acaricide Selection
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Pesticide Use
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Some general points to consider if you spray for ticks:
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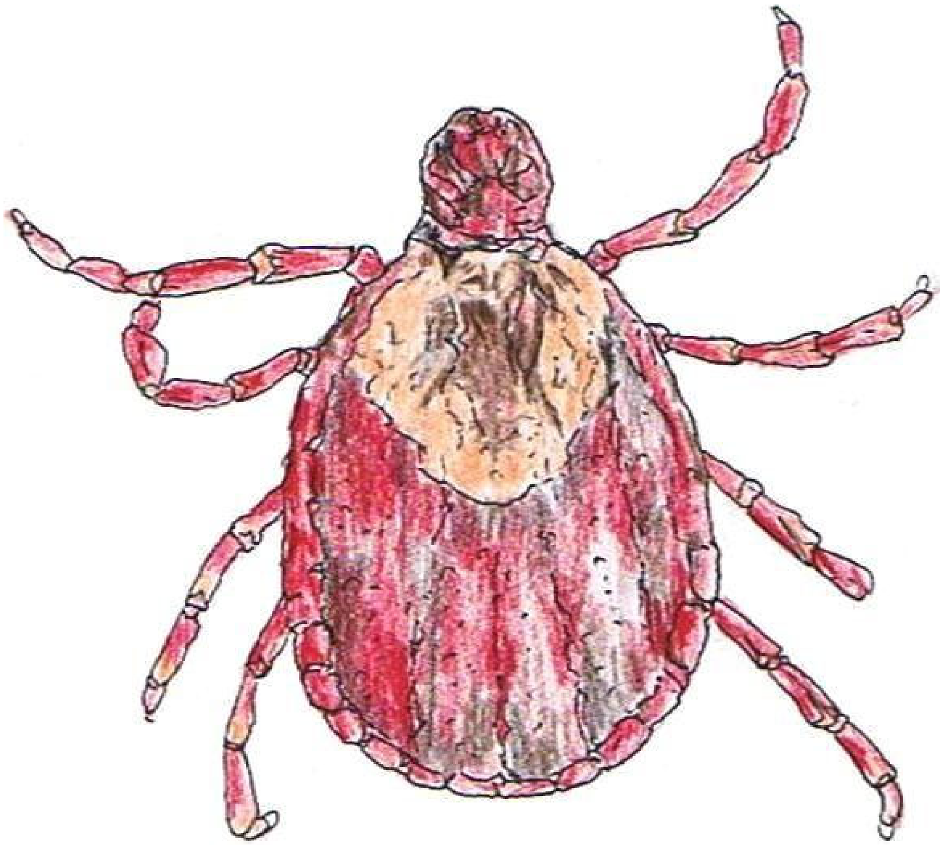
Research has demonstrated the effectiveness of properly timed acaricide applications. If ticks are present, treat edge areas of the property where turf grass and woods meet) plus 12 feet into the woods to create a protective barrier. Shady areas of the lawn adjacent to the woods and areas landscaped with shrubs and ground covers such as pachysandra may also be treated.

Rocky Mountain Wood Tick *Dermacentor andersoni*

This tick is found from the western counties of Nebraska and the Black Hills of South Dakota to the Cascade and Sierra Nevada Mountains, and from northern Arizona and northern New Mexico in the United States to British Columbia, Alberta, and Saskatchewan in Canada.



ROCKY MOUNTAIN TICK

Their habitat is primarily fields and forested areas. This species is especially prevalent where there is brushy vegetation that encourages the small mammal hosts of immature ticks and sufficient forage to attract the large hosts of the adults. Immatures feed mainly on small mammals such as ground squirrels and chipmunks, and adults on cattle, sheep, deer, humans, and other large mammals.

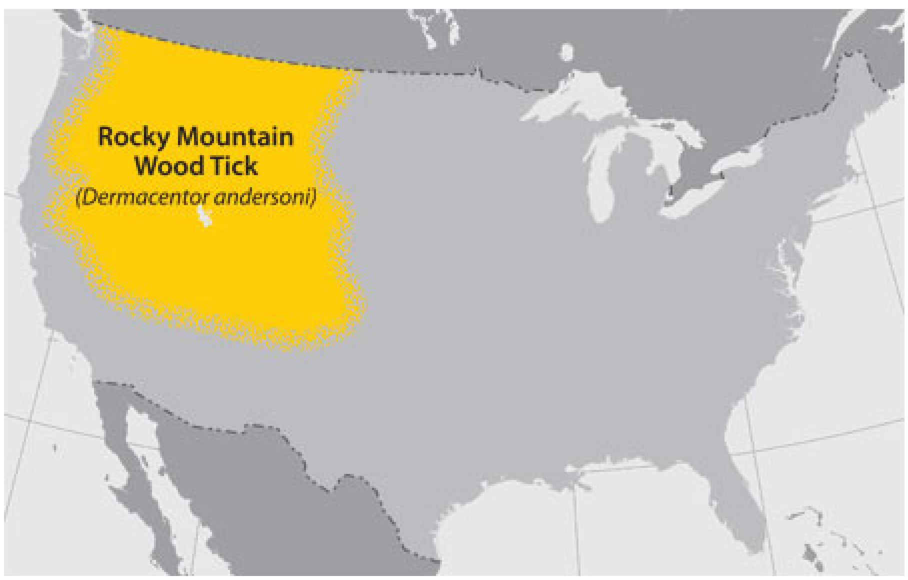
Rocky Mountain Wood ticks are found predominantly in shrublands, lightly wooded areas, open grasslands, and along trails, mainly at lower elevations. All life stages of this tick can transmit Colorado tick fever virus (CTFV) to humans, and Rocky Mountain spotted fever (RMSF) rickettsia (Rickettsia rickettsii) to humans, cats, and dogs. Rocky Mountain wood tick saliva contains a neurotoxin that can occasionally cause tick paralysis in humans and pets; usually a bite from an adult female induces an ascending paralysis that dissipates within 24-72 hrs after tick removal.

Diagnostic features
Larva only has 3 pairs of legs. Nymph has 4 pairs. Single pair of spiracular openings (stigmata) close to the coxae (leg bases or segments) of the 4th pair of legs (except in larvae) Terminal capitulum (mouthparts) visible from above in all stages except the egg, of course. A large sclerite called the Scutum present dorsally behind the capitulum. The scutum almost entirely covers the back of the male, but only partly covers the back of the female. Eyes, if present, are on the scutum. Sexual dimorphism in size and color is frequent. The female is often larger. Posterior margin of opisthosoma usually sub-divided into sclerites callel festoons. Pedipalps rigid along the chelicerae, not leg-like. Single pair of spiracular openings (stigmata).

Females lay about 4,000 eggs in plant debris on the soil or in crevices in construction materials, usually in masses of hundreds at a single location. Unfed larvae may live for 1-4 months, nymphs for 10 months, and adults for more than 12 months (Goddard 1989). Adults and nymphs can be found from March to mid- summer. Larvae are active throughout the summer and are associated with cool soil temperatures, shallow soil, abundant leaf litter, and high relative humidity.

This species is the primary vector of Rocky Mountain spotted fever in the Rocky Mountain States and is also known to transmit Colorado tick fever and Tularemia. It also carries tick paralysis in the United States and Canada.

Approximate distribution of the Rocky Mountain Wood Tick



Ticks are highly sensitive to carbon dioxide, exhaled by animals as they breathe, and seek it out. Ticks will travel up the stems of grasses and low shrubs to wait for a passing mammal to brush against them. The ticks will then cling to the new host and attach itself by secreting a cement-like substance around its mouthparts and insert it into the host. If the tick has not found a host by the time that hot summer temperatures arrive, it seeks cover under leaves and remains dormant until the next year. Peak periods of tick activity can begin as early as March during warm seasons. They usually subside by mid-July.

Ticks produce a toxin that can cause paralysis in animals. This systemic toxic reaction is reversible when feeding ticks are removed from the victim soon after the onset of symptoms. If the paralysis is allowed to progress too long, death can result from respiratory paralysis. Symptoms of tick paralysis occur only after the female tick has been feeding for about five days. The victim may feel perfectly well one day, but on the next day they may complain of numbness in the feet and legs, and have problems walking. Following these complaints and difficulties, the patient may find it impossible to stand.

Hands and arms are usually affected next. There is frequently a partial paralysis of the throat muscles, with an accompanying difficulty in swallowing. Loss of control over the tongue may occur; with the result that speech becomes difficult. Pain and fever do not usually accompany the other symptoms. Although the nature of the toxin is unknown, it is generally believed that tick paralysis is caused by a substance produced in the tick's salivary glands. One theory suggests that the host's tissues react in response to tick saliva to produce a metabolic toxemia. Still another theory postulates that symbiotic microorganisms living in the salivary glands of the tick produce the toxin while the tick feeds.

A person suspected of having tick paralysis should be stripped and examined carefully for the presence of feeding ticks. Particular attention should be paid to the armpits, neck nape, crotch and groin areas. Remove any ticks with forceps, eyebrow tweezers, or tissue or cotton held the fingers. Do not use bare fingers. Avoid folklore remedies, such as the use of petroleum jelly or hot matches. These do little to encourage a tick to detach from skin, and may make matters worse by irritating the tick and stimulating it to release additional saliva or regurgitate gut contents, increasing the chances of transmitting the pathogen. After the tick has been removed from the patient, the wound should be examined to establish that head and mouthparts have been extracted with the tick body. If left embedded in the skin, these can cause infection. The wound should then be painted with an antiseptic. Following these procedures, get the patient to a physician as soon as possible and inform the doctor that you suspect tick paralysis.

Rocky Mountain Spotted Fever (RMSF)
In addition to Rickettsia rickettsii, the agent of Rocky Mountain spotted fever (RMSF), several other tick-borne species of Rickettsia, broadly grouped under the heading "Spotted Fever group Rickettsia (SFGR)" have been shown to cause human infections. Tick-borne SFGR are transmitted to humans by the bite of an infected tick, and may cause similar signs and symptoms to those observed for RMSF. These pathogens include several species of Rickettsia found in the United States, including R. parkeri and Rickettsia species 364D. In addition, numerous tick-borne SFGR pathogenic to humans have been described internationally, including but not limited to R. conorii and R. africae. Travelers may be at risk for exposure to these pathogens when engaging in behaviors that place them at risk for tick exposure, and physicians should maintain awareness of these diseases when a patient presents with a febrile illness within 2 weeks of returning home. Rickettsial infections with R. africae have been reported as a common cause of fever in travelers returning from South Africa.

Rocky Mountain Spotted Fever (RMSF) Symptoms
The initial symptoms of tick-borne SFGR infections generally include fever, headache, fatigue, and muscle aches. A maculopapular or petechial rash may be present, and frequently a distinctive eschar (blackened or crusted skin) may develop at the site of a tick bite. Multiple eschars may be present if more than one tick bite occurred.

The observance of an eschar at the site of tick bite may provide the clinician with a diagnostic clue that can help differentiate the infection from RMSF, although eschars may also be rarely reported with R. rickettsii infection. The severity of illness may vary depending on the species. For example, human infections with R. parkeri and R. africae are generally considered mild and to some extent self-limiting infections. In contrast, R. conorii and some other SFGR infections may be more severe. Prompt treatment with doxycycline is recommended if tick-borne SFGR is suspected, and should never be delayed pending the outcome of diagnostic tests.

Treatment
Tick-borne SFGR infections respond well to treatment with doxycycline, and this is considered the antibiotic of choice for patients of all ages.

Recommended Dosage
Doxycycline is the first line treatment for adults and children of all ages:

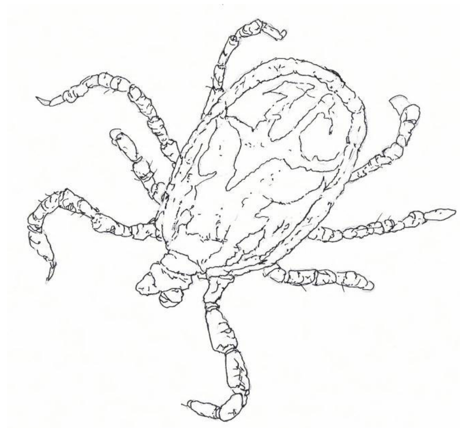
- Adults: 100 mg every 12 hours
- Children under 45 kg (100 lbs): 2.2 mg/kg body weight given twice a day
- Patients should be treated for at least 3 days after the fever subsides and until there is evidence of clinical improvement. Standard duration of treatment is 7 to 14 days.

Be sure to tell your physician if you become ill within 2 weeks of a tick bite or exposure to ticks, either within the United States or internationally.

Prevention of Other Tick-borne Spotted Fevers
The best prevention is to prevent tick bites. Information on preventing tick bites includes use of personal insect repellents, choosing clothing that limits tick attachment, and avoiding areas where ticks may be present.

Rodent Tick *Ornithodorus hermsi* –Soft Tick

This soft tick is a common rodent parasite and a vector of relapsing fever. It is found along the Pacific coast and in the Rocky Mountain region of the U.S. Larvae can expand to three times their normal size after a blood meal and appear bright red. They are sometimes mistakenly referred to as strawberry seed insects.



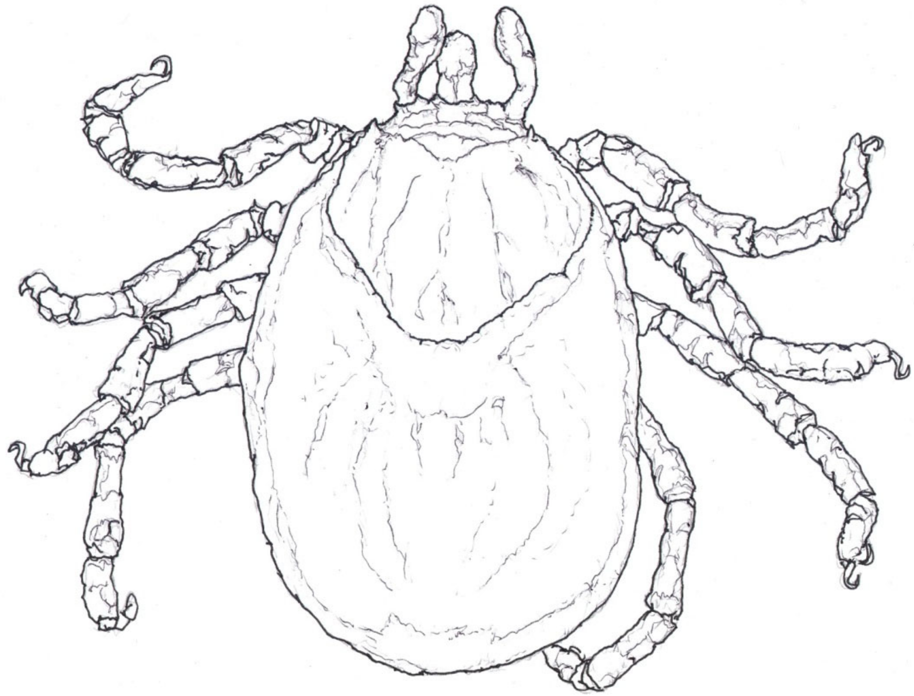
RODENT TICK

Ornithodoros hermsi is a soft-bodied tick of the family Argasidae. It is one of the smallest ticks of the species *Ornithodoros*. Females are larger than the males. *O. hermsi* has a multihost lifecycle, and some females have been observed to live four years without any blood meals. They are parasites of rodents and other small mammals. The most favored host is the western chipmunk, *Eutamias* spp.

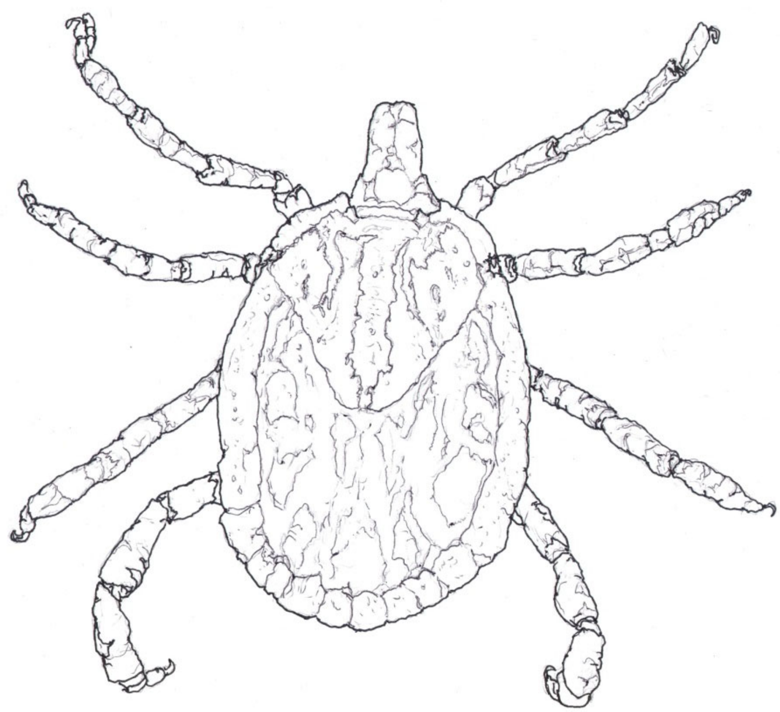
Lifecycle
As do all other species of ticks, *O. hermsi* begin as eggs, then larvae, then nymphs, to adult ticks. *O. hermsi* has two larval molts and three nymphal stages. The nymphal blood meals and the greater volume of blood intake will increase the development from nymphs to adults and decrease the number of nymphal stages.

Distribution
O. hermsi is found in the northwestern region of the United States, including Washington, Oregon, California, Idaho, Colorado, and even northern Arizona and New Mexico. Additionally, the species is found in southwest British Columbia, Canada. The ticks are found in timbered regions and at high altitudes. Wood used for fuel and lumber are common locations, as are hollow pine logs, Douglas firs, and wooden cabins. *O. hermsi* has been found in the nests of birds and rodents.

Medical and veterinary importance
This species is a vector of *Borrelia hermsii*, which can cause tick-borne relapsing fever in humans. which are spread from *O. hermsi* to animals to humans or directly to humans. Unlike hard-bodied ticks, Ixodidae, *O. hermsi* feeds on a host for a short period ranging from 15–20 minutes. They often feed at night. The bites are not painful nor noticeable, which is dangerous as victims of the bite will not know they are affected until symptoms of TBRF appear. The a higher transmission of *B. hermsii* in late-stage nymphs and adult ticks is because they have larger blood meals and, therefore, longer feeding times



GROUNDHOG TICK



GULF COAST TICK

Spinose Ear Tick *Otobius megnini* –Soft Tick

This soft tick gets its name from the habit of larvae and nymphs to infest the ears of cattle, horses, mules, etc., and occasionally people. This is a 1-host tick.

SPINOSE EAR TICK

Life Cycle
O. megnini has a single host life cycle in which the larvae and nymphs remain deep within the external ear canal of their definitive host for long periods of time. The eggs are laid on or near the ground and hatch in 18 days or more. The larvae then crawl up vegetation, fence posts, or anything else they can find to wait for a host. They are capable of surviving without a host for more than 2 months. Once the larvae find a host, they migrate to the ears and feed for 5-10 days. They then molt and become nymphs, still remaining within the host's ear. The nymphs feed for about a month, after which they crawl out of the ear onto the ground in order to molt again and become adults. It is possible for the nymphal stages to remain in the ear for 1-7 months, and adults can produce eggs for up to 6 months. Spinose ear tick adults do not feed; they absorb water from the atmosphere in order to survive.

Larvae crawl up on vegetation, and after finding a host, move to the animal's ear. Both the larvae and nymphs feed in the ear which, because of irritation and secondary infections, causes a condition called *"canker ear"*. Although cattle are the primary host, this tick parasitizes many species of wild animals. It is generally found in drier range areas of the United States and in Nebraska is reported only in the western section, except for feedlot cattle that originated in the west or southwest.

Considerable attention has been given to ticks in the last few years because of Lyme disease. The main vector for this disease is the deer tick, *Ixodes dammini*. Recently, taxonomists have disagreed on how to classify the tick. Entomologists in the southern United States have used genetic technology to compare the deer tick to the blacklegged tick, *Ixodes scapularis*, and say they are the same species. It is possible but hasn't been proven that other ticks can transmit the arthritis-like Lyme disease.

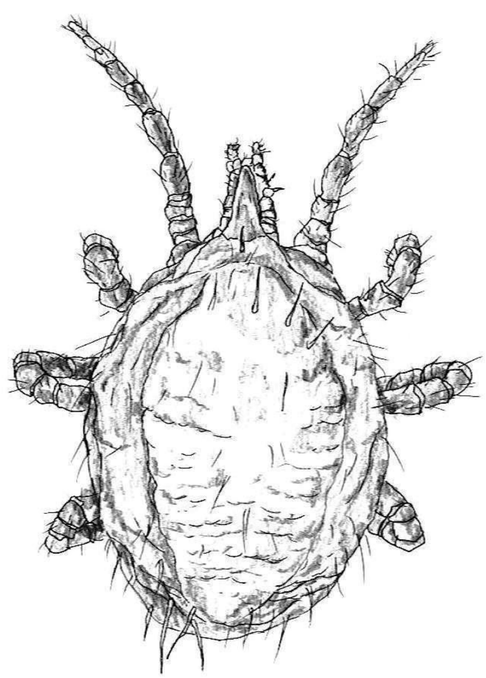
Disease transmission by ticks is called biological transmission. This means that ticks feed on blood of a host infected with the disease.

The disease organism may complete its life cycle in the tick and/or multiply to the point that when the tick feeds again, it can transmit the disease to another susceptible animal. Generally, the disease organism will pass from adult to egg, or egg to larva, to nymph to adult, in efficient vector species of ticks.

As with many soft ticks, the mouthparts of *O. megnini* are not visible from the dorsal view. The nymph is somewhat violin shaped with tiny, backward-projecting spines covering the body, which are the reason for the description *spinose* in the common name. The adult may achieve 10 mm (0.4 in) in length, is brown, and has a slightly granular body cuticle. The male and female close resemble each other; neither possesses a scutum.

Habitat

Although spinose ear ticks are generally associated with semiarid or arid environments such as those found in the southwestern United States, they can also be found in other climate areas due to widespread interstate transportation of animals. Larvae and nymphs usually remain within the ears of their host. Fully grown nymphs and adults live off the host, but still within the host's general environment. They usually prefer dry, protected places such as in cracks and crevices or under logs and fence posts.



FOWL MITE

Tropical Tick *Amblyomma Species*

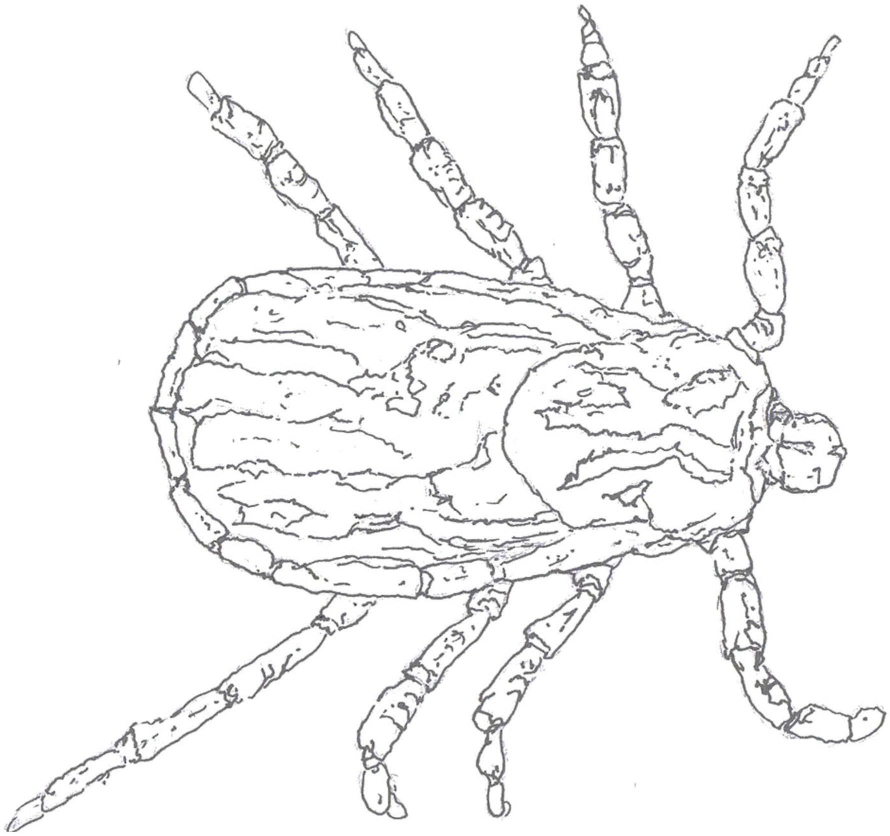
Tropical bont ticks were introduced onto the eastern Caribbean island of Guadalupe in the 1800's on cattle imported from French West Africa. Since then, and particularly in recent years, the tropical bont tick has spread as far north as Puerto Rico and as far south as Barbados and St. Vincent. The reason the tick is dangerous is that it harbors organisms that cause serious diseases in cattle and wildlife.

The life cycle of *Amblyomma* ticks may take from 5 months to 4 years to complete. Thus, the disease agents may persist in the environment, inside these ticks, for a long time. The immature stages of the tick feed on a wide variety of livestock as well as wildlife (e.g., deer, ground-dwelling birds, small mammals, reptiles, and amphibians). The ticks thus spread the infectious diseases efficiently and rapidly.

The tropical bont tick carries a particularly nasty and fatal livestock and wildlife disease called heartwater and a cattle disease called acute bovine dermatophilosis (a skin infection). These diseases are not themselves contagious but are transmitted by the ticks. Scientists believe that much of the recent inter-island spread of the tropical bont tick has occurred through movement of infested migratory birds, and in particular cattle egrets.

Because these egrets can fly between the Caribbean and Florida, there is a significant chance that tropical bont ticks could come with them to this country. Heartwater and related diseases would follow, damaging the cattle industry and driving up the price of your next hamburger.

Winter Tick *Dermacentor albipictus*



WINTER TICK

This one host tick is found throughout North America. It is widely distributed throughout California, but populations are concentrated around the central coastal and sierra foothill areas. It primarily feeds on horses and deer from fall through early spring. Heavy infestations of horses may cause emaciation and anemia (Furman and Loomis 1984).

After hatching from the egg, larvae attach to a host, feed and detach, remaining on the animal. Subsequently, they molt to the nymphal stage, resume feeding and detach again. After they develop into adults and feed once again, they drop to the ground and lay their eggs, where the cycle begins once again.

Geographic Distribution
For each species of tick, the geographic distribution, habitat, hosts, life cycle, seasonal abundance, responses to environmental factors, as well as direct and indirect medical effects are described. Information concerning the removal of ticks, outbreaks of tick-borne diseases, and natural enemies are presented. Tick management approaches including methods of population monitoring, decision-making, and intervention are described. All of these tick species are attracted to carbon dioxide and generally prefer low light intensity, high relative humidity, and protection from constant breezes. Temperature and humidity are the two most important environmental factors affecting survival.

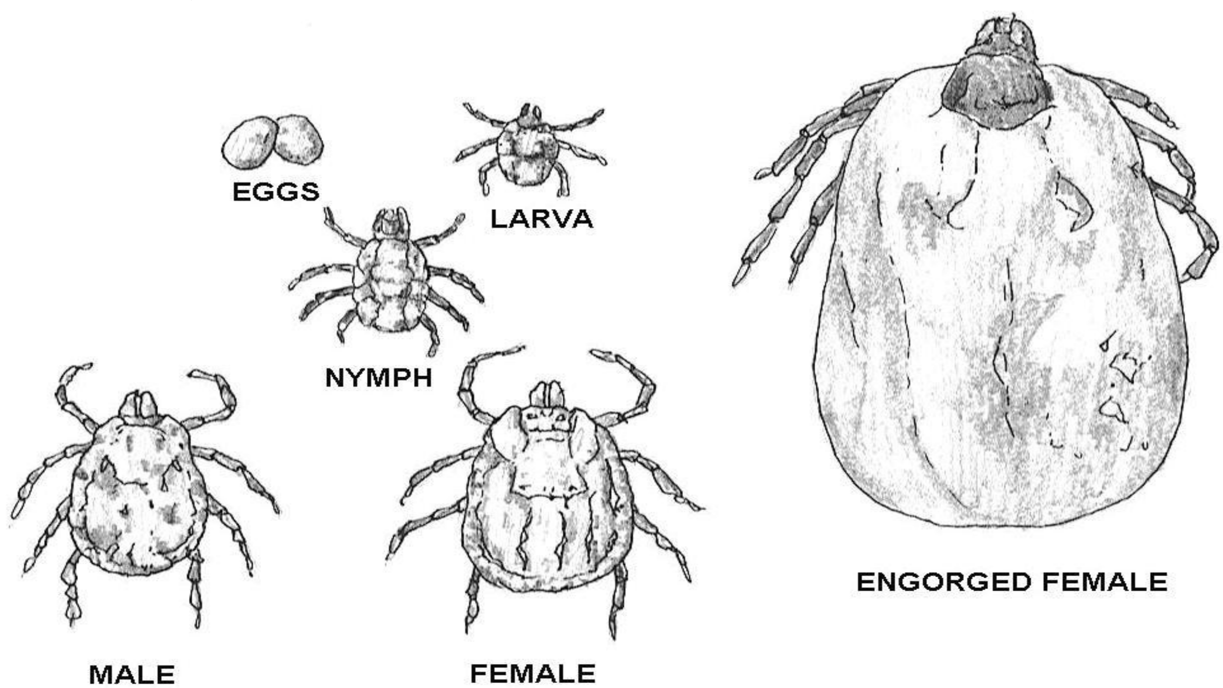
Ticks are highly sensitive to carbon dioxide, exhaled by animals as they breathe, and seek it out. Ticks will travel up the stems of grasses and low shrubs to wait for a passing mammal to brush against them. The ticks will then cling to the new host and attach itself by secreting a cement-like substance around its mouthparts and insert it into the host. If the tick has not found a host by the time that hot summer temperatures arrive, it seeks cover under leaves and remains dormant until the next year. Peak periods of tick activity can begin as early as March during warm seasons. They usually subside by mid-July.

Diagnostic Laboratory Tick Identification
Ticks can be submitted to the Insect Diagnostic Laboratory at Cornell University for identification. A $35.00 identification fee applies per sample. Please do not mail ticks in in alcohol due to mail regulations.

The Diagnostic Laboratory does not test ticks for any disease agents. If you want the tick tested please check with your physician or local county health office for the names of laboratories performing tick-testing services. Be sure to ask for information regarding price, response time, and proper procedure for mailing. Some laboratories perform tests only on living or recently dead ticks, while other laboratories test ticks preserved in alcohol.

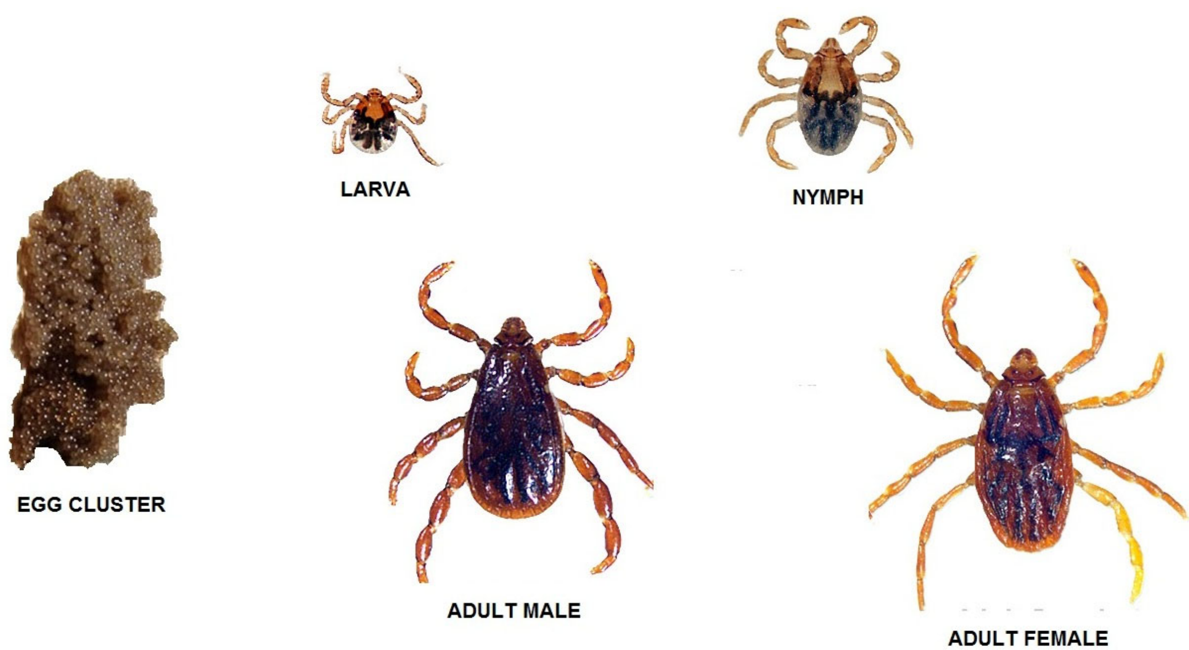
Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.



BLACK LEGGED TICK (Stages)

LONE STAR TICK STAGES



AMERICAN DOG TICK STAGES

Non-Chemical Control of Ticks Sub-Section

Education
Ticks are important disease vectors in many regions of the country. Park visitors and employees need to be aware of tick species and diseases present in their area, as well as personal protection measures that should be taken by anyone who will be in tick-infested areas. Parks should use interpretive displays to inform their visitors about ways to avoid contacts with ticks.

Biological Control
Several species of ants are known to feed on ticks. Recently, releases of the parasitic wasp *Hunterellus hookeri* have been made on several small islands on the New England coast. This wasp attacks *Ixodes dammini* and has been recovered from some of the release sites (Van Driesche, personal communication).

Habitat Management
Wherever possible, visitor activities should be directed towards areas that provide unfavorable habitat for ticks.

Regular inspection of the facility or home should be performed to determine when tick management needs to be initiated.

The basic principles of management include isolation of susceptible domestic animals from known tick populations and rotation of pasture or run areas to reduce tick populations.

Removal of shrubs, trees, or tall grass can be useful in situations where it is consistent with policy regarding use of the area.

Removal of Excess Brush
Dense shrub and tree cover and tall grass provide harborage for both ticks and their animal hosts. Removal of excess brush and shrubbery and clearing the canopy trees so that 50% to 80% of a management area is exposed to direct sunlight at any time are recommended control practices for walkways, parks, and landscaped grounds (Hair and Howell 1968).

Grass should be kept below 6" in height to allow the penetration of sunlight and soil ventilation. Such techniques result in higher soil temperatures, lower humidities, and lower soil moisture, all of which lead to higher tick mortality. In one study, such techniques resulted in 75% to 90% control of different tick life stages of the Lone Star tick (Mount 1981). Mowing vegetation with a bush-hog rotary mower reduced adult deer tick populations by 70% in another study (Wilson 1986). Controlled burning of habitat may reduce tick numbers and may be feasible in a park if it is consistent with a fire management plan. For example, burning tick-infested areas on Great Island, Massachusetts reduced deer tick populations by 38% six months after the burn (Wilson 1986). However, the long-term implications of burning are unclear. Burning typically improves deer browse in the area; thus increased deer abundance may result in the movement of ticks back into the area.

Research has shown that high deer populations can lead to increased Lone Star and deer tick populations since there will be more hosts from which a blood meal can be obtained.

Reducing the deer population may be a feasible tick management strategy. This reduction has been experimentally demonstrated in Massachusetts (Wilson et al. 1988), although the decline in tick numbers may not correspond directly to the reduction in deer population.

Managing Deer Populations

Managing deer populations by hunting, fencing, or environmental modification should be considered seriously before tick infestations become severe and should be done within state and local guidelines. Efforts at deer management should be done in coordination with state natural resources and wildlife department personnel.

Under unusually high tick population pressure it may be necessary to treat indoor areas. The major methods of nonchemical indoor tick management include regular inspection, elimination of animal (especially rodent) harborage areas, use of food and waste-handling procedures that minimize animal entry and harborage, and animal-proofing buildings. This includes sealing all holes in foundations and walls, and screening (with heavy gauge metal screen) aboveground windows, vents, and other openings through which animals may enter. An 18" perimeter border of gravel may prevent movement of ticks from grass areas into buildings. Cracks and crevices around the base of buildings should be sealed with caulk.

Recommended practices include frequent examination of clothing (preferably by another individual) and the body (after showering), destruction of collected ticks, and wearing protective clothing (e.g. coveralls with trouser cuffs taped to shoes, high- top shoes, socks pulled over trouser cuffs, long-sleeved shirts or jackets, or mesh jackets). Clothing should be light-colored so ticks may be easily seen.

Low-Level Tick Infestations

Periodic surveys of potential or known habitats can reveal the presence of low- level tick infestations, thus indicating the need for application of management practices to prevent or retard further population increase.

Integrated Tick Management

The Connecticut Agricultural Experiment Station

Integrated pest management (IPM) basically involves the selection and use of several methods to reduce, rather than eliminate, a pest population with expected ecological, economic, and sociological costs and benefits. For ticks, this may involve the use of landscape practices to reduce tick and host animal habitat adjacent to the home, management or treatment of host animals, targeted applications of least-toxic pesticides to high-risk tick habitat – all in conjunction with tick checks and other personal protective measures to either reduce the number of infected ticks and number of tick bites. The ultimate goal, of course, is to reduce the number of human cases of disease as much as possible with the resources available.

A decision has to be made on how much one is willing to spend and what ecological impact one is willing to tolerate to reduce the risk of a tick-borne illness. An integrated management approach does not necessarily preclude the use of pesticides, for example, but seeks to use chemicals effectively and responsibly in order to minimize and reduce exposure and use. Research and computer models have shown that pesticides are the most effective way to reduce ticks, particularly when combined with landscaping changes that decrease tick habitat in often-used areas of your yard.

Tick Distribution and Creating a Tick Safe Zone in the Residential Landscape
Tick abundance is related to landscape features of the suburban residential environment that provide a suitable environment for the tick and its animal hosts, particularly white-tailed deer and white-footed mice. While there is a lot of variation in tick numbers between homes, larger properties are more likely to harbor ticks because they are more likely to have woodlots. The blacklegged tick is found mainly in densely wooded areas (67% of total sampled) and ecotone (22%), which is unmaintained transitional edge habitat between woodlands and open areas. Fewer ticks are found in ornamental vegetation (9%) and lawn (2%). Within the lawn, most of the ticks (82%) are located within 3 yards of the lawn perimeter particularly along woodlands, stonewalls, or ornamental plantings. Tick abundance in manicured lawns is also influenced by the amount of canopy vegetation and shade. Groundcover vegetation can harbor ticks. Woodland paths also may have a high number of ticks, especially adults, along the adjacent grass and bushes.

The lawn perimeter, brushy areas and groundcover vegetation, and most importantly, the woods, form the high-risk tick zone. The idea for residential tick management is to create a tick managed area around your home that encompasses the portions of the yard that your family uses most frequently. This includes walkways, areas used for recreation, play, eating or entertainment, the mailbox, storage areas and gardens.

- Adopt hardscape and xeriscape (dryer or less water demanding) landscaping techniques with gravel pathways and mulches. Create a 3-foot or wider wood chip, mulch, or gravel border between lawn and woods or stonewalls.
- Consider a pesticide application as a targeted barrier treatment.
- Consider areas with decking, tile, gravel and border or container plantings in areas by the house or frequently traveled.
- Consider host products to kill ticks on deer or rodent hosts.
- Discourage rodent activity. Cleanup and seal stonewalls and small openings around the home.
- Keep grass mowed.
- Manage pet activity, keep dogs and cats out of the woods to reduce ticks brought back into the home.
- Move children's swing sets and sand boxes away from the woodland edge and place them on a wood chip or mulch type foundation.
- Move firewood piles and bird feeders away from the house (see section on small mammals and birds).
- Remove brush and leaves around stonewalls and wood piles.
- Remove leaf litter, brush and weeds at the edge of the lawn.
- Restrict the use of groundcover, such as pachysandra in areas frequented by family and roaming pets.
- Trim tree branches and shrubs around the lawn edge to let in more sunlight.
- Use plantings that do not attract deer or exclude deer through various types of fencing.
- Widen woodland trails.

Landscape Management
Residential landscapes are designed for a variety of aesthetic or environmental reasons and "tickscape" practices can be a part of the landscape in Lyme disease endemic areas. Landscape modifications can create an environment unattractive to primary tick hosts and may decrease the abundance of ticks that are present in parts of the yard. Fewer ticks have been found on well-maintained lawns, except on areas adjacent to woodlands, stonewalls, or heavy groundcover and ornamental vegetation.

This section provides some ideas on how to incorporate tick management into the landscape. Clearing leaf litter and woodchip barriers have been documented to help reduce ticks on the lawn. However, landscape practices to create a lower risk tick zone will not directly eliminate many ticks and you may need to consider integrating other tick control practices into the overall program. Landscape work may also be expensive, not acceptable to some residents, and must be done by residents on their own property. In computer simulations of a hypothetical community of 10,000 individuals, a 90% habitat reduction on lawns, 80% habitat reduction in ecotone, and 10% reduction in forested areas by nearly half the residents resulted in the prevention of only a moderate number of Lyme disease cases in comparison to the application of acaricides or treatment or removal of deer. Landscape management alone may not reduce disease incidence, as the undetected bite of only one infected tick is required for transmission of *B. burgdorferi*.

Woodland edge and leaf litter are high-risk areas for nymphal blacklegged ticks!
In most cases, alterations will be made to an existing landscape, although landscape architects and designers should also incorporate tick safe landscaping concepts into major renovations or new construction. There are several basic interrelated concepts in modifying the landscape to create an area with fewer ticks and environmentally acceptable management practices.

- Open up to direct solar exposure the part of the landscape used or traveled frequently by family members to reduce tick and small mammal habitat and cover. Bright, sunny areas are less likely to harbor ticks.
- Isolate areas used by the family or public (i.e., lawns, play areas, recreational or ball fields) from tick habitat or tick hot spots (i.e., woods, dense vegetation, groundcover, stonewalls).
- Use hardscape and xeriscape landscaping (i.e., brick, paving, decking, gravel, container plantings, low water requirement plantings) in areas immediately around the house that are frequently used.
- In cases where environmentally acceptable alternatives to large tracts of open lawn or only small lawn areas are desired, consider butterfly gardens, vegetable gardens, formal herb gardens, colonial style gardens, wildflower meadows and hardscapes. Elimination of woodland and all wildlife habitats is not necessary or environmentally desirable. Some evidence suggests a lack of biodiversity and a landscape that specifically favors deer and mice increases tick abundance and transmission of *B. burgdorferi*. The key factor appears to be the presence and abundance of deer.

Reducing Tick Habitat
Altering the landscape to increase sunlight and lower humidity may render an area less hospitable to ticks. Management of the habitat should focus on the areas frequently used by the family, not necessarily the entire property. To reduce ticks adjacent to homes, prune trees, mow the lawn, remove leaf litter accumulations around the house and lawn perimeter, and cut grass, weeds, and brush along edges of the lawn, stonewalls, and driveways. Plants can be pruned to provide open space between the ground and base of the plant. Individual shade trees, with the exception of fruit trees like crab apple that are attractive to deer, and small ornamental stands in the open lawn will probably not contribute to the tick numbers unless surrounded by groundcover.

Ticks also may be found in groundcover such as *Pachysandra*. Restrict the use of groundcovers to less frequently used areas of the yard. Clean up the vegetation around or even seal stonewalls near the house. The removal of leaf litter has been shown to reduce the number of *I. scapularis* nymphs on some properties. Mowing and removing cover vegetation around the house also will discourage rodent hosts. Leaf litter and other plant debris can be raked or blown out from under shrubs and bushes (use tick protection measures while handling leaf litter). Composting or removal by appropriate bagging is acceptable method of disposing of leaf litter.

Leaves should not be simply moved to another part of the property. Some communities will compost collected leaves and provide the compost to residents for free or a nominal charge.

Move swing sets and playground areas out or away from the woodland edge!
Play activity can be a high-risk activity for tick exposure and children have some of the highest rates of Lyme disease. The use of hardscapes, mulches, and xericape landscaping techniques can help reduce tick habitat and isolate parts of the yard from tick hot spots. Hardscapes refer to nonliving features of the landscape like patios, decks, and paths. Mulches are used to suppress weeds and help retain soil but can also help reduce tick movement. In the laboratory, untreated landscape, landscape stones pinebark woodchips have been shown to deter tick movement and around homes, a three-foot wide or broader woodchip barrier may help reduce tick abundance on the lawn, although results have been found to vary widely from home to home and from year to year depending upon other factors (i.e. density of woods, amount of shade, initial tick densities).

Mulches are often organic materials like bark chunks or shredded bark, but can also be small stones or gravel. Wood chip and tree bark, gravel, or similar landscaping materials between woods or stonewalls and lawn as a buffer or barrier can help reduce the number of ticks on the lawn and delineate the tick zone. Quality of the landscape material may also influence results as wood chips from chipped trees, especially if it contains leaves, quickly degrade and may soon be no different than leaf litter. Properly maintained each year, the barrier may allow fewer ticks to migrate from the woodlands into the lawn. It also serves as a reminder that people who cross the barrier may be at higher risk of getting ticks. The application of a barrier or buffer will be easiest where there is a sharp delineation between the woods and lawn. A pesticide application can be focused on the landscape barrier or buffer zone to increase the effectiveness of the barrier. Move swing sets and sandboxes away from the woodland edges and place on a covering of smooth bark, mulch or other suitable material.

Xeriscaping is the application of water conserving landscape practices. This approach reduces habitat cover; helps isolate frequently used areas, can provide an attractive focal area in the yard or garden and reduce maintenance and water, fertilizer, and chemical use. Many drought resistant plants are also deer resistant. Landscapes can incorporate formal or informal designs around play, eating, or pool areas. Landscape materials such as laid brick, wood decking, stone paving, raked gravel or pea gravel (set down slightly from bordering bricks, stone, or paved areas), and concrete (exposed aggregate can provide varying attractive colors and textures and edged with brick or tile) can be used to create a patio and paths. Gravel can be laid over a layer of crushed stone covered with black plastic to discourage weed growth. Some plantings can be in raised beds or containers.

Management of Host Animals
Food and shelter are essential requisites for wildlife. The residential landscape can be particularly attractive to white-tailed deer and conducive to mice, both important hosts in the prevalence of ticks and Lyme disease. One component of a tick management strategy is managing deer and small rodent activity in your yard. Some landscaping practices discussed in the previous section can also help manage key animals in the landscape. Stonewalls, woodpiles, and dense vegetation can harbor rodents.

White-tailed Deer, *Odocoilius virginianus* (Zimmerman)
In the northeast from New Jersey to Maine, the deer population is estimated at 1,918,000 animals. In Connecticut, the number of deer has increased from about 12 in 1896 to over 76,000 today. Overabundance of deer is associated with problems such as deer/vehicle collisions, agricultural

damage, lack of forest regeneration, detrimental impacts on other wildlife (especially birds), damage to residential landscapes, and the rising incidence of Lyme disease. The fault is not in the animal. Who has not appreciated the thrill of a glimpse of these animals in the meadow or grazing in our landscapes? The problem is in their numbers. There only need be fewer of them. Mature, shaded forests with poor forage and browse support low densities of deer and fewer ticks. A mosaic of light fragmented woodland and woodland edges, clearings and abundant shrubs, berries, grass, and forbs and a lack of predators are ideal for deer. Fencing out deer can allow greater landscape options favorable to other wildlife.

The abundance and distribution of *I. scapularis* has been directly related to the size of the deer population. It has been estimated that over 90% of adult ticks feed on deer. Therefore, deer are key to the reproductive success of the tick. Deer transport blood-engorged female ticks into the property where they can lay thousands of eggs, increasing the number of larval ticks available to feed on small animals. Reservoir incompetent, deer do not infect feeding ticks with Lyme disease bacteria. Larvae of *I. scapularis* pick up the spirochetes when they feed on small animals, especially mice, which are reservoir competent hosts. Island or peninsular communities with extremely high deer densities have superabundant tick populations. Conversely, islands without deer do not appear to support *I. scapularis* or *B. burgdorferi*. Deer management options include deer fencing, repellents, and deer resistant landscape plantings. Dogs also may help deter deer, but to be effective the animal may have to be active both day and night, something a family pet may not do.

Deer Fencing
Fencing is the most effective method to control access by deer to a property. Fences can keep deer from large garden beds or small to moderate sized home lots. The exclusion of deer from areas of 15 to 18 acres with a slant high-tensile electric fence was shown to reduce the abundance of *I. scapularis* nymphs by as much as 84% and larval ticks by 100% approximately 70 yards or greater inside the fence. Fencing of smaller areas also may be beneficial, but tick management practices within the enclosure and the use of an insecticide at the fence perimeter may also be needed. A deer fence does not stop small animal movement and tick movement. Barrier fencing can be used to protect individual trees, shrubs or other plantings from deer.

There are many types of deer fences and selection will depend upon deer pressure, area to be protected, and site characteristics. The most common choice in a fence is a plastic or wire mesh vertical fence. An electric fence is another option. A number of companies specialize in providing deer fencing and can provide the fencing materials or install the fence. However, many communities have local restrictions or ordinances on the type and height of fencing allowed – check with your local authorities.

Non-Electric Fence
The fence may be vertical or three-dimensional. A vertical fence requires the least space and a wide variety of fence materials and designs are available. Increasingly, a black polypropylene plastic fence-like mesh or steel mesh is being used instead of a chain-link for vertical fences because of reduced cost, low maintenance, long life, and near invisibility, an attractive feature in the residential landscape. The plastic material comes in rolls of various lengths and 7.5 feet wide and can be fastened to existing trees or several different types of posts.

White flags should be attached at around 4 feet to signal the presence of the fence. While deer can jump a vertical fence of eight feet from standing position, they rarely do so and are more likely to try and push under fencing. Proper anchoring or staking of the fence along the ground is important. Single or multiple electric strands also can be placed along the top of a vertical wire or mesh fence. Another option is a slant deer fence set at an angle of 45 degrees use in areas with moderate to high deer densities, but it requires more space (about 6 feet of horizontal space).

Deer cannot clear both the height and width of the fence and often find them under the top outer wire. Solid 5- to 6-foot fences are also effective access gates, driveway gates (can be remotely controlled in expensive systems), or in ground driveway deer grates (similar to cattle guards) will be needed to completely enclose the area and allow owner and vehicle access.

Electric fence – An electric fence requires maintenance, proper grounding, and may not be appropriate in many residential settings. A vertical or slant seven-strand, high-tensile electric fence is very effective for larger areas where deer densities are high.

Deer Repellents
The use of deer repellents may reduce damage to plants and help defer the animals elsewhere, but by itself will not impact tick abundance unless deer consistently avoid the property entirely. Repellent performance is highly variable depending upon the product (most are either odor or taste-based), rain, frequency of application, and the availability of other food sources for deer. Nevertheless, some repellents are fairly effective with low to moderate deer densities.

Deer Resistant Plantings
Substituting less palatable landscape plants may discourage browsing around the home, reduce damage to ornamental plants and may help make the yard less attractive to deer, though deer will also readily graze on lawns. The use of deer resistant plantings may have no impact on ticks unless deer consistently avoid the property and the use of these plants specifically as part of tick management has not been examined. It simply seems to make sense to make your yard and plantings less attractive to deer.

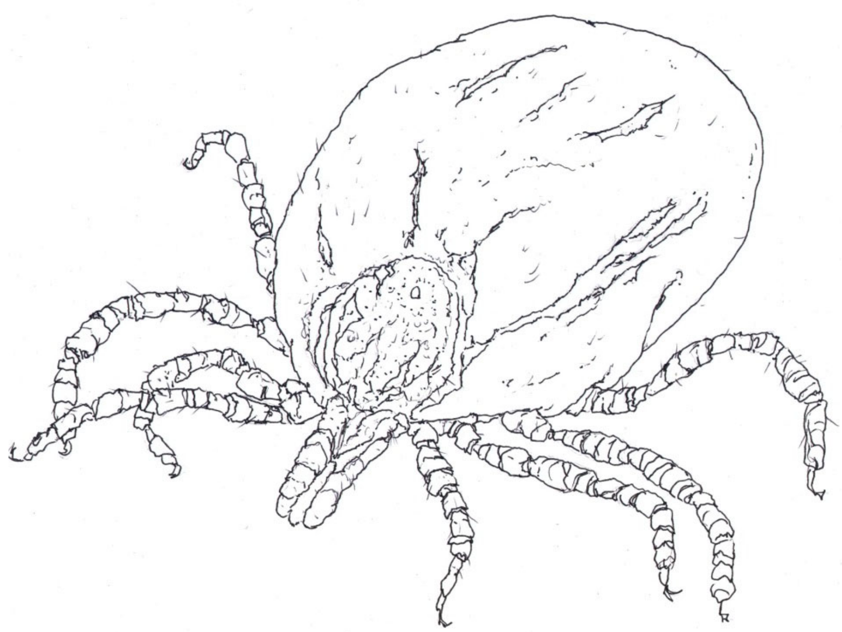
No plant is completely browse resistant and susceptibility depends upon deer density, food availability, and food preferences, which can vary regionally. Plant selection will depend partly upon the type of terrain you have: a sunny, moist yard, a dry, sunny garden, a dry shady garden, or a wet, shady yard, proximity to streams or ponds and effect desired (e.g., fragrance, foliage color, seasonal color, showy borders, etc.). Use of native shrubs and trees is encouraged and the use of invasive plantings is discouraged. Non-native invasive plants, some of which are very resistant to deer browse damage, can crowd out natives. Examples include Japanese barberry, multiflora rose, Asiatic bittersweet, and several non-native honeysuckles. Lists of invasive species and alternative plantings are usually available from state agencies, universities, or environmental groups in each state.

Groundcovers like pachysandra and myrtle, while browse resistant, have been found to harbor ticks and may not be the most appropriate choice near heavily used areas around the house, porch, or mailbox. In general, ornamental grasses and ferns are browse resistant and may be good choices in sunny and moist shady areas, respectively. A number of medicinal herb varieties, ornamental herbs, and butterfly garden plants are resistant to deer browse. The most browse resistant plantings should be placed at the edges and entrances of the property and the most browse susceptible plants closer to the house or areas frequented by people and pets. Susceptible plants can be surrounded by less palatable species.

Clean up fruits and other produce from under trees or crop plants. While eliminating cover like mixed tall grass and brush may help discourage deer from bedding near the home, deer will bed wherever they consider it safe – even open lawn. In a study of tick egg-laying, female ticks from deer were found to survive in field bedding areas and lay eggs from which larvae successfully hatched. However, larval survival in the field was shorter than in the woods and they are less likely to be picked up by a mouse host.

Deer Reduction and Management
Some communities have explored the reduction of deer through regulated hunting or controlled hunts to reduce problems associated with deer overabundance. The incremental removal and virtual elimination of deer has been shown to substantially reduce tick abundance, but observational studies and computer models suggest deer densities must be reduced to very low levels (possibly as low as 8 deer per square mile or less) to interrupt the transmission of Lyme disease. With the exception of some islands or peninsulas, the need for such a drastic reduction in deer population to achieve satisfactory control levels may render this strategy unrealistic in many areas.

Conversely, unregulated deer populations may lead to steadily increasing tick populations. It is not clear if *I. scapularis* can be maintained on medium-sized animal hosts in the absence of deer. Adult ticks also feed on opossums, raccoons, skunks, foxes, dogs and other animals. However, tick densities may be low enough to interrupt the enzootic cycle and transmission of *B. burgdorferi* to humans.



FEMALE DEER TICK (Engorged)

Lethal management options for deer are effective, though controversial, while the use of anti-fertility agents is experimental and labor intensive.

A community that wishes to implement a deer management program, especially in densely populated urban and suburban areas must deal with hunting restrictions, real or perceived safety or liability concerns, and conflicting attitudes on managing wildlife. Since most land in the northeast is privately held, homeowner views and hunter access are important to deer management. Any deer population control program would require an initial reduction phase to lower high densities of deer and a maintenance phase to keep the deer population at the desired targeted level. Deer capacity for reproduction is high and deer herds can potentially double in size in one year. Management would be an ongoing process.

Host-Targeted Chemical Tick Control for White-tailed deer
The U.S. Department of Agriculture has developed a new experimental approach for the application of topical acaricides to white-tailed deer to kill ticks feeding on the deer. It consists of a feeding station with four paint rollers that hold the pesticide. Deer self-treat as they brush against the rollers when they feed. These 4-posters were evaluated in the northeastern United States for the control of the blacklegged tick, having performed well in a trial against lone star ticks on deer in Texas.

Computer models indicated that 95% of *I. scapularis* on 90% of a local deer population could dramatically reduce the tick population in treated area over a period of several years. While usage of the devices is generally high (> 90%), utilization of the devices by deer was extremely when alternative food sources were available (i.e., acorns). The treatment of deer with 2% amitraz reduced tick abundance in the treated communities by around 64-69% by the fifth and sixth year in comparison with untreated areas. The use of 10% permethrin resulted in a 91-100% reduction of larval, nymphal, and adult questing ticks in sampled plots. According to computer simulations, this approach, in principal, could provide control greatest reduction in Lyme disease with the least direct community involvement (i.e. number of direct participating households).

The American Lyme Disease Foundation (Somers, NY) holds the license to the product's patent and works with Dandux Outdoors (Ellicott City, MD) for manufacturing the device.

Home Remedies Repellants for Ticks and Mosquitoes

Rose Geranium, by putting a few drops—no more!— on our dogs' collars, to see if it would repel ticks. Lo and behold, we went from 20 ticks a day on each dog, to none. The second best essential oil for repelling ticks is American Pennyroyal (also called tickweed).

Use Bounce Fabric Softener Sheets...Best thing ever used in Louisiana, just wipe on & go...Great for Babies.

Bob, a fisherman, takes one vitamin B-1 tablet a day April through October. He said it works. He was right. Hasn't had a mosquito bite in 33 years. Try it. It has worked for everyone he has talked into trying it. Vitamin B-1(Thiamine Hydrochloride 100 mg.)

If you eat bananas, the mosquitoes like you, - something about the banana oil as your body processes it. Stop eating bananas for the summer and the mosquitoes will be much less interested.

This is going to floor you, but one of the best insect repellents someone found (who is in the woods every day), is Vick's Vaporub.

Plant marigolds around the yard--the flowers give off a smell that bugs do not like, so plant some in that garden also to help ward off bugs without using insecticides.

"Tough guy" Marines who spend a great deal of time "camping out" say that the very best mosquito repellant you can use is Avon Skin-So-Soft bath oil mixed about half and half with alcohol.

One of the best natural insect repellants that I've discovered is made from the clear real vanilla. This is the pure Vanilla that is sold in Mexico. It works great for mosquitoes and ticks, don't know about other insects. When all else fails--get a frog.

Simple Solution:
- 2 tablespoons vegetable or nut oil (almond oil contains sulfur, a repellent in its own right)
- 10 to 25 drops Rose Geranium essential oil

Combine the ingredients in a glass jar; shake to blend.
Makes: 2 tablespoons
Shelf Life: 6 months
Dab a few drops on your skin or clothing, making sure to avoid eyes.

Caution
Skip the Pennyroyal if there is anyone pregnant (including pets) in the home, as it can induce miscarriage. And as always, use essential oils with caution as they can burn the skin and harm eyes. Don't use these essential oils around cats.

Tick Identification Section Post Quiz

Fill-in-the-blank

1. Lone star tick __________can be irritating; redness and discomfort at a bite site does not necessarily indicate an infection. The nymph and adult females most frequently bite humans and transmit disease.

Deer Tick Life Cycle

2. The deer tick passes through four life stages (egg, larva, nymph, adult), over _________.

Egg to Larvae

3. Their first host is generally a mouse or other medium-sized mammal or bird. Once attached, the larvae embed their mouth parts and feed for several days. If the host is infected with a disease such as Lyme, the tick may be infected during this feeding. The larvae then drop off their host into the __________________ where they molt into the next stage, the nymph, remaining dormant until the following spring.

Larvae to Nymph

4. Nymphs are commonly found on the forest floor in leaf litter and on low lying vegetation. Their host primarily consists of mice and other rodents, deer, birds and unfortunately ______.

Nymph to Adult

5. Over the next few months the nymph ____________into the larger adult tick, which emerges in fall, with a peak in October through November. Both male and female adults find and feed on a host, then the females lay eggs sometime after feeding.

6. ________________are human-biting ticks with a broad host range, found predominantly in shrublands, chaparral, and along trails from Oregon to northern Baja California and Mexico. Pacific

7. The Lone Star tick is found in wooded areas, especially where there is dense underbrush, but it is also found in scrub, meadow margins, hedge rows, cane breaks, and marginal vegetation along rivers and streams. The immatures and adults feed on a wide variety of mammals (including humans) and_________________________.

8. The Bacterium**:** Even though spirochetes have been seen in *A. americanum* ticks by microscopy, attempts to culture it in the laboratory have consistently failed. Modified BSK (Barbour-Stoenner-Kelly) is the best medium for cultivating the______________, *B. burgdorferi*, but is apparently not suitable for cultivating the spirochete found in *A. americanum*.

Winter Tick *Dermacentor albipictus*

9. This one host tick is found throughout North America. It is widely distributed throughout California, but populations are concentrated around the central coastal and sierra foothill areas. It primarily feeds on horses and deer from fall through early spring. Heavy infestations of _____________may cause emaciation and anemia (Furman and Loomis 1984).

10. Ticks are highly sensitive to _______________, exhaled by animals as they breathe, and seek it out. Ticks will travel up the stems of grasses and low shrubs to wait for a passing mammal to brush against them.

Tick Identification Section Post Quiz Answers

1. Saliva, 2. A two year period, 3. Leaf litter, 4. Humans, 5. Molts, 6. Pacific Coast ticks, 7. ground-feeding birds, 8. Lyme disease spirochete, 9. Horses, 10. Carbon dioxide

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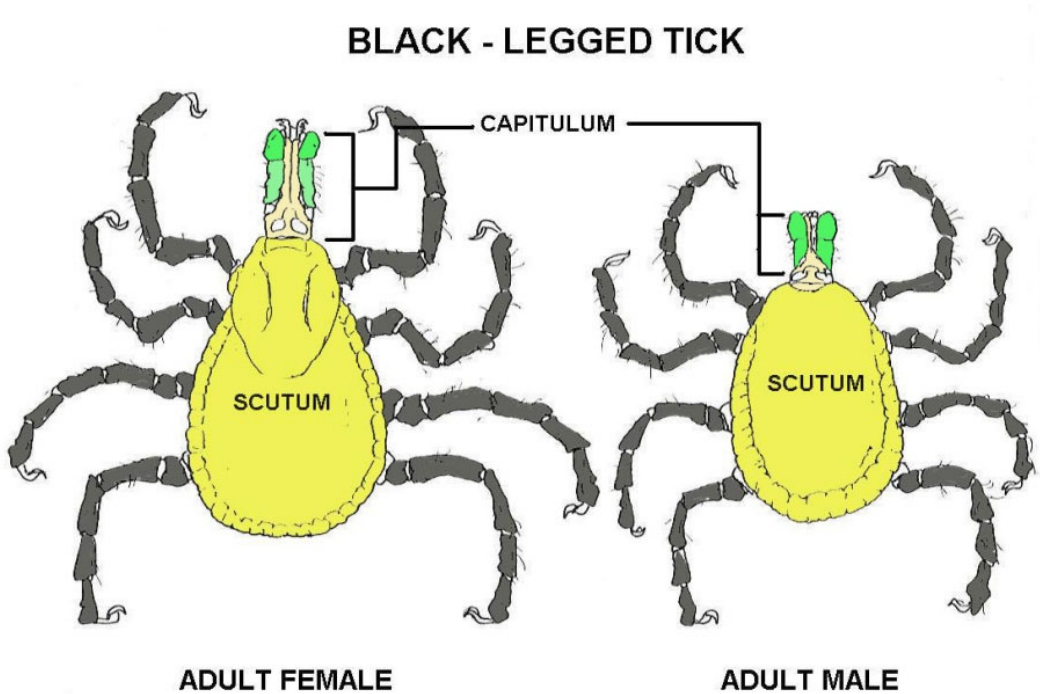
Credits

University of United States Cooperative Extension in Lancaster County (http://lancaster.unl.edu/enviro/pest/bug.htm)

Photos by Jim Kalisch, UNL Entomology

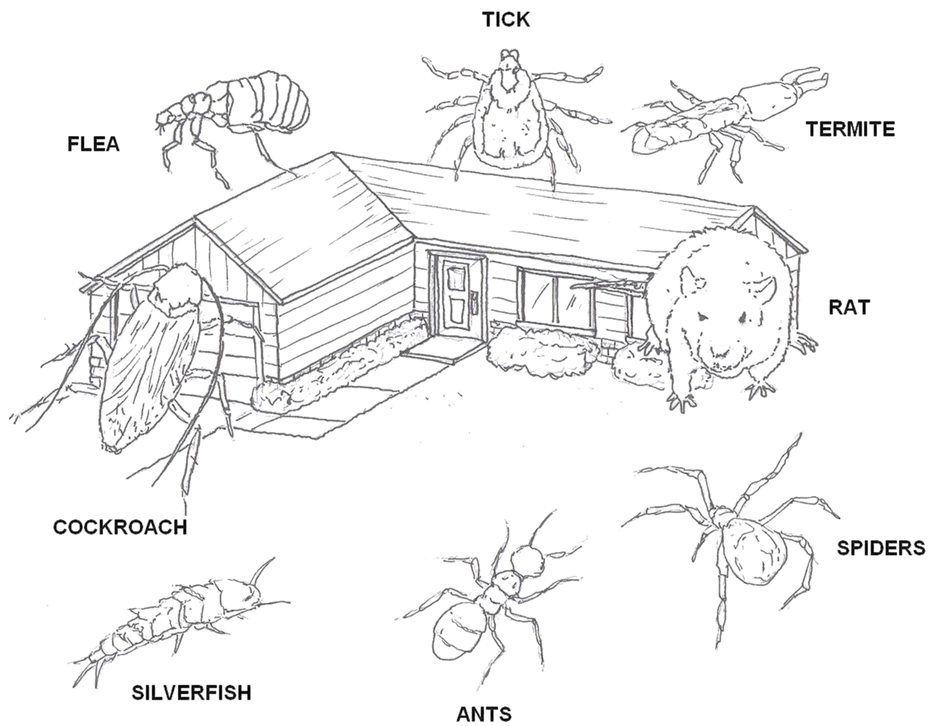
Dr. Roger Chalkley



Topic 14 - Cockroach Section

Section Focus: You will learn the basics of cockroaches, including the life cycle, behavior and related scientific information. At the end of this section, you the student will be able to understand and describe general information about the cockroach, including the life cycle and related information. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: The humans and cockroach relationship is quite remarkable. These rapidly adapting insects have followed humans as pets from the time when our ancestors lived in caves to now when we have moved to skyscrapers. There cannot be a single home in the world which has not been shared with cockroaches. In fact, most of you must be facing these disgusting creatures on a daily basis — seeing them crawl on your sink, running down the pipe hole, lurking over a pile of garbage or resting peacefully in the corners of your refrigerator. The fact is, cockroaches come out in the daylight only when the place is too crowded for them or when they are ill.



COMMONLY FOUND HOUSEHOLD PESTS DIAGRAM

Introduction

Cockroach or "roach" is the common name for an order of insects - the most familiar of which are characterized by their oval shape, foul odor, and status as household pests. About 4,000 roach species are known worldwide; most inhabit the warm tropical regions of the globe. About 25 species have attained worldwide distribution due to accidental transport in commerce and their affinity for human habitation and trash. Among these roaches are most of the important pest species that spread disease.

Cockroaches are an ancient group of insects, having changed little in appearance except in size in thousands of years. In the past, cockroaches were up to 10 times larger in size than today. Fossil records indicate that they were here from the beginning of time and will outlive humans.

Cockroaches are among the hardiest (robust; capable of enduring difficult conditions) insects on the planet. Some species are capable of remaining active for a month without food and are able to survive on limited resources like the glue from the back of postage stamps. Some can go without air for 45 minutes. In one experiment, cockroaches were able to recover from being submerged underwater for half an hour.

Cockroaches are the most important insect pests in households and public places. The cockroach is a dorso-ventrally flattened insect, meaning it looks flatter when view from the side compared to its shape when viewed from above. The head is orientated in a downward-facing position and from above is largely covered by the pronotum. These insects have chewing mouth parts, three pairs of legs and usually two pairs of wings. The two pairs of wings are differentiated with the tegmina (forewings) being leathery and serving to protect the fan-shaped hindwings, which are the primary flight wings. The wings show mainly longitudinal veination. These incredible creatures were designed with well-developed compound eyes and very long filiform antennae are found on the head.

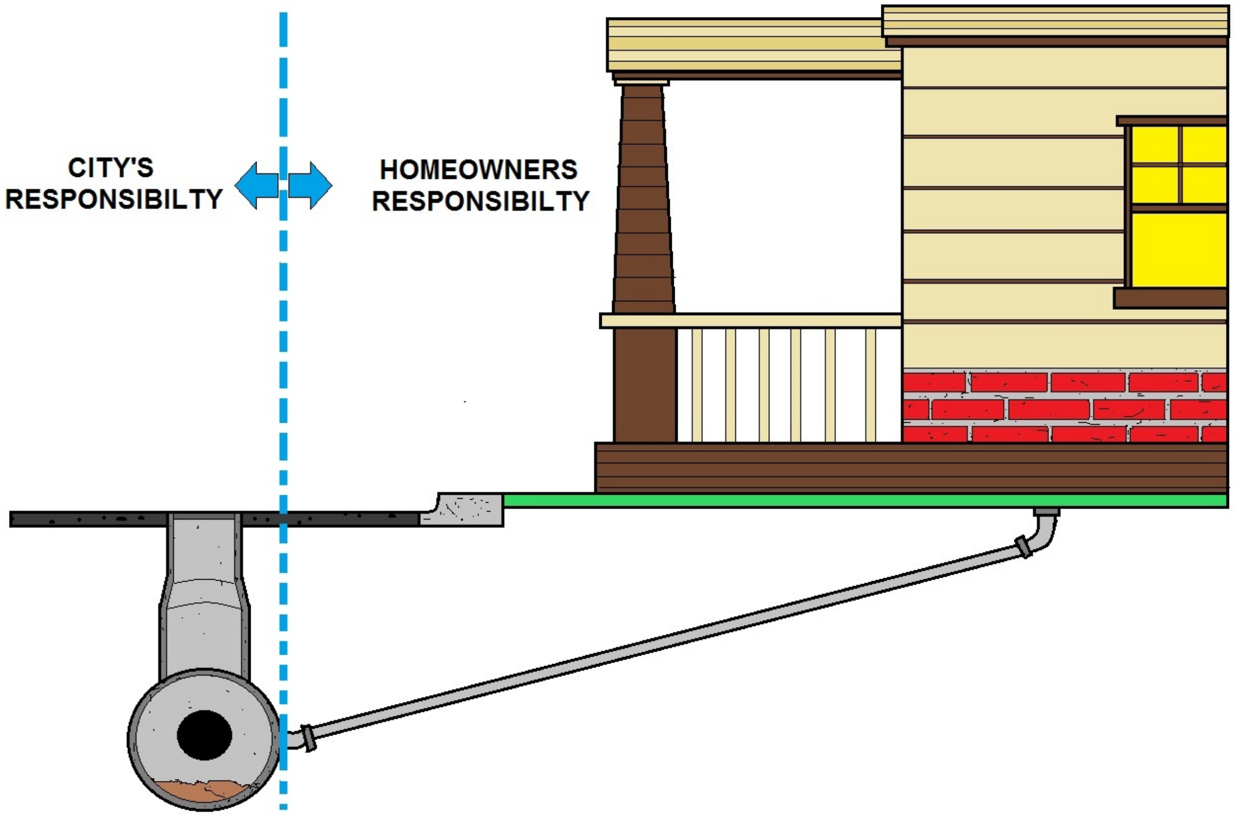
Hated Insect

The cockroach is probably one of the best known and most hated of insects. Roaches are associated by most people as an indicator of filth and unhygienic conditions. This is the primary reason we need pesticide applicators. Roaches are a super intelligent insect and will outwit most of us. It will take you years to master cockroach control.

As earlier stated, some 4000 species are recognized today. Of these, only about twelve are commonly associated with humans. We will examine these later. Due to their close contact with humans, several common names have been given to these insects. The actual name cockroach is reportedly of Spanish origin, derived from the word "***Cucaracha***". We will cover these twelve in detail later in the course.

It is popularly suggested that cockroaches will "inherit the earth" if humanity destroys itself in a nuclear war. Cockroaches do indeed have a much higher radiation resistance than vertebrates, with the lethal dose perhaps 6 to 15 times that for humans. However, they are not exceptionally radiation-resistant compared to other insects, such as the fruit fly.

The cockroach's ability to withstand radiation better than human beings can be explained through the cell cycle. Cells are most vulnerable to the effects of radiation when they are dividing. A cockroach's cells divide only once each time it molts, which is weekly at most in a juvenile roach. Since not all cockroaches would be molting at the same time, many would be unaffected by an acute burst of radiation, but lingering radioactive fallout would still be harmful



DESIGNATING SEWER MAINTENANCE RESPONSIBILTY

Most municipalities will have the collections (sewer) department dust the manholes and other areas that cockroaches live.

Background
Cockroaches live in a wide range of environments around the world. Pest species of cockroaches adapt readily to a variety of environments, but prefer warm conditions found within buildings. Many tropical species prefer even warmer environments and do not fare well in the average household. The spines on the legs were earlier considered to be sensory, but observations of their locomotion on sand and wire meshes have demonstrated that they help in locomotion on difficult terrain. The structures have been used as inspiration for robotic legs.

Cockroaches leave chemical trails in their feces as well as emitting airborne pheromones for swarming and mating. These chemical trails transmit bacteria on surfaces. Other cockroaches will follow these trails to discover sources of food and water, and also discover where other cockroaches are hiding. Thus, cockroaches can exhibit emergent behavior, in which group or swarm behavior emerges from a simple set of individual interactions.

Daily rhythms may also be regulated by a complex set of hormonal controls of which only a small subset have been understood. In 2005, the role of one of these proteins, Pigment Dispersing Factor, was isolated and found to be a key mediator in the circadian rhythms of the cockroach.

Research has shown that group-based decision-making is responsible for complex behavior such as resource allocation. In a study where 50 cockroaches were placed in a dish with three shelters with a capacity for 40 insects in each, the insects arranged themselves in two shelters with 25 insects in each, leaving the third shelter empty. When the capacity of the shelters was increased to more than 50 insects per shelter, all of the cockroaches arranged themselves in one shelter. Researchers found a balance between cooperation and competition exists in the group decision-making behavior found in cockroaches. The models used in this research can also explain the group dynamics of other insects and animals.

Live Everywhere
Characteristically, most roaches hide in cracks and crevices or between surfaces that provide darkness and cover. Inside buildings, roaches move freely between rooms or adjoining apartments using wall spaces, plumbing and other utility installations. They can be carried into structures in food and beverage boxes, grocery sacks, animal food and other household goods.

Cockroaches can eat almost anything, but they are especially partial to starchy foods and meat products. They feed on such diverse items as cereals, pastries, chocolate, milk products, beverages, cooked potatoes, glue, book bindings, wall paper, animal food, fresh or dried blood, excrement, dead animals and leather products. We will cover this area again in the Inspection and Management Sections.

Nocturnal
Cockroaches are mainly nocturnal and will run away when exposed to light. A peculiar exception is the Asian cockroach, which is attracted to light. Another study tested the hypothesis that cockroaches use just two pieces of information to decide where to go under those conditions: how dark it is and how many other cockroaches there are.

The study conducted by José Halloy and colleagues at the Free University of Brussels and other European institutions created a set of tiny robots that appear to the roaches as other roaches and can thus alter the roaches' perception of critical mass. The robots were also specially scented so that they would be accepted by the real roaches.

Additionally, researchers at Tohoku University engaged in a classical conditioning experiment with cockroaches and discovered that the insects were able to associate the scent of vanilla and peppermint with a sugar treat.

Cockroaches Verses Beetles
Some homeowners confuse cockroaches with beetles, but adult cockroaches have membranous wings and lack the thick, hardened forewings (elytra) of beetles. Roaches are nocturnal and have a tendency to scatter when disturbed. Immature cockroaches (nymphs) look like adults, but are smaller and do not have wings.

Cockroach Facts

- Roaches can survive without food for up to a month.
- A cockroach can live underwater for up to 30 minutes and can hold its breath for as long as 40 minutes.
- A roach can live without its head for an entire week. The only reason a roach will die is that it can't drink without a head and needs moisture to survive.
- Roaches can travel at speeds of up to three miles an hour, so they can easily make it from one part of a home to another.
- A cockroach that is only one-day old can run almost as quickly as its parents. Since these creatures are only about the size of a speck of dust at that point, you are unlikely to see them.

Common Cockroach Related Diseases
Cockroaches can carry disease-causing bacteria, spreading salmonella, dysentery, gastroenteritis and diarrhea among others. The organisms causing these diseases are carried on the legs and bodies of cockroaches, and are deposited on food and utensils as cockroaches feed and move about.

Cockroaches are Arthropods (Lobsters to Spiders)
Cockroaches are arthropods having jointed appendages, an exoskeleton (hard, external covering made mostly of chitin), segmented body, ventral nervous system, open circulatory system, digestive system, and specialized sensory receptors.

Cockroaches are True Insects
Cockroaches are classified as "true insects" (that is, species classified in the Class Insecta). True insects are distinguished from all other arthropods in part by having ectognathous, or exposed, mouthparts. They are sometimes termed Ectognatha, which is synonymous with Insecta. We will cover this area in better detail in a few more pages.

Cockroaches are Generally Lazy Creatures
Cockroaches can move quite quickly only when necessary, and can run as fast as three miles per hour. Even a one-day-old baby cockroach can run almost as fast as a grown-up one. However, roaches only move quickly when they detect danger. The rest of the time, they are lazy. A cockroach spends approximately three-quarters of its time just resting in one spot. Roaches that live near humans spend most of their time hiding in dark, wet, secluded places. They can happily survive and reproduce in just a few inches of space.

Cockroaches may Fly - Others are Unable to Fly
Cockroaches rely on their feet more than their wings when trying to get away from predators. Although many species have wings, most cockroaches can only fly over a short distance. Some species of cockroaches cannot fly at all. American cockroaches, for example, only use their wings to glide from a high spot to a lower surface. The wings of the roaches are often quite tough and sturdy, so they also act as a shield. But the tough wings, coupled with a relatively heavy body mass, make it difficult for roaches to fly efficiently.

Limit Water Access to Cockroaches
Any areas of standing water will attract roaches, including water bowls for pets and puddles on bathroom or kitchen floors. These should usually be emptied each evening, and any dripping

faucets should be fixed. Some people go so far as to seal their faucets and drain pipes, particularly in older buildings that are more prone to leaks.

Distribution and Habitat
Cockroaches are abundant throughout the world and live in a wide range of environments, incredibility from the tropics and subtropics. Cockroaches can withstand extremely cold temperatures, allowing them to live in the Arctic.

Some species are capable of surviving temperatures of -188 °F by manufacturing an insect type of antifreeze made out of glycerol.

Cockroaches occupy a wide range of habitats. Many live in leaf litter, among the stems of matted vegetation, in rotting wood, in holes in stumps, in cavities under bark, under log piles and among debris.

Some roaches live in arid regions and have developed mechanisms to survive without access to water sources. Other types of roaches live in the forest canopy where they may be one of the main types of invertebrate present. Here they may hide during the day in crevices, among dead leaves, in bird and insect nests or among epiphytes, emerging at night to feed.

Aquatic Cockroach
Some cockroaches are aquatic, living near the surface of water bodies, including bromeliad phytotelmata, and diving to forage for food. Most of these highly designed creatures respire by piercing the water surface with the tip of the abdomen which acts as a snorkel, but some carry a bubble of air under their thoracic shield when they submerge.

Necessary to Fix all Leaks
A slow drip underneath a counter or washing machine may not be problematic on a day-to-day basis, but the moist environment it creates might be just enough to encourage a roach to settle in and build a family.

Habitations of the Primary Found Cockroaches
Of the six common pest species, German and brownbanded cockroaches inhabit buildings, whereas the oriental, smokybrown, American, and Turkestan cockroaches usually live outdoors or in masonry enclosures away from buildings, only occasionally invading buildings themselves. It is important to correctly identify the species involved in a cockroach infestation so that the most effective control method(s) may be chosen.

Natural Enemies of Cockroaches
There are numerous parasites and predators of cockroaches, but few of them have proven to be highly effective for biological control. Wasps in the family Evaniidae are perhaps the most effective insect predators, as they attack the egg cases. Wasps in the family Ampulicidae are predators on adult and nymphal cockroaches (e.g., *Ampulex compressa*). The house centipede, is probably the most effective control agent of cockroaches, though most homeowners find the centipedes themselves objectionable.

Collective Decision-Making
Sociable cockroaches often display collective decision-making when choosing food sources. When a sufficient number of individuals (a "quorum") exploits a food source, this signals to

newcomer cockroaches that they should stay there longer rather than leave for elsewhere. Cooperation and competition are balanced in cockroach group decision-making behavior.

Cockroaches appear to use just two pieces of information to decide where to go, namely how dark it is and how many other cockroaches there are. A study used specially-scented roach-sized robots that appear to the roaches as real to demonstrate that once there are enough insects in a place to form a critical mass, the roaches accepted the collective decision on where to hide, even if this was an unusually light place. Use this information for proper bait or trap placement. These highly designed creatures will adapt and out think you in common treatments.

Social Behavior

Sociable German cockroaches show different behavior when reared in isolation from when reared in a group. In one study, isolated cockroaches were less likely to leave their shelters and explore, spent less time eating, interacted less with other cockroaches when exposed to them, and took longer to recognize receptive females. Because these changes occurred in many contexts, some have suggested this action as constituting a behavioral syndrome. These effects might have been due either to reduced metabolic and developmental rates in isolated individuals or the fact that the isolated individuals hadn't had a training period to learn about what others were like via their antennae.

Individual American cockroaches appear to have consistently different "personalities" regarding how they seek shelter. In addition, group personality is not simply the sum of individual choices, but reflects conformity and collective decision-making

The gregarious German and American cockroaches have elaborate social structure, chemical signaling, and "social herd" characteristics. Lihoreau and his fellow researchers stated: "*The social biology of domiciliary cockroaches ... can be characterized by a common shelter, overlapping generations, non-closure of groups, equal reproductive potential of group members, an absence of task specialization, high levels of social dependence, central place foraging, social information transfer, kin recognition, and a meta-population structure".*

Cockroaches Sleep

Cockroaches have activity rhythms, i.e. regular times in the day when they are quiet and hide away from the rest of the world as well as wakeful times when they are active, seeking food, water and a mate.

In general, most pest species of cockroaches are active (i.e. awake) during the four hours after lights-out. That is why they are often visible when you go to the refrigerator for that midnight snack or come home late from the movies.

Roaches cue on that time when you normally shut off all the lights and go to bed. That ensuing four hours of activity is enough for them to get all their important business done without the high probability of running into you. In a study, one four-hour stretch of food availability was enough to get them through an entire molting cycle of about 6 days. In a high density cockroach infestation, the population may be forced to come out at other times to find food.

If you have lowered the population down by using insecticides and management strategies, whether that is a commercial insecticide or your boric acid application, the remaining few cockroaches will be satisfied with the four-hour stretch after lights-out and you will rarely see them. While we sleep they are active; while they sleep we are active.

Crazy Customer World

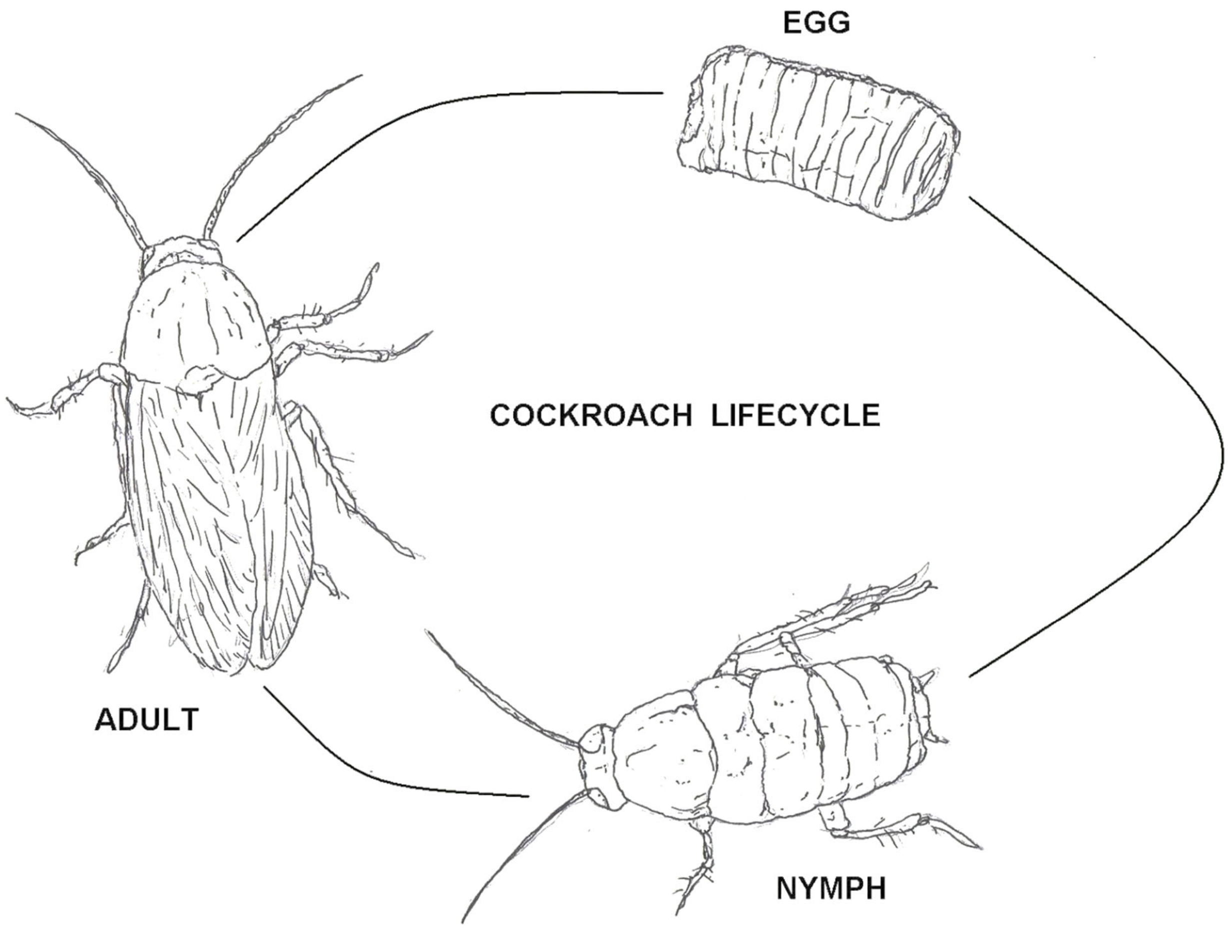
Nothing more ironic than spraying a home for roaches and having the homeowner raising giant hissing cockroaches as pets. The little cockroaches are pests but the big ones are pets, like a dog.

How about finding a restaurant filled with cockroaches and both the insect type and seeing the large seafood type of roach-like lobster being served hot to human customers?

Cockroach’s Life Cycle

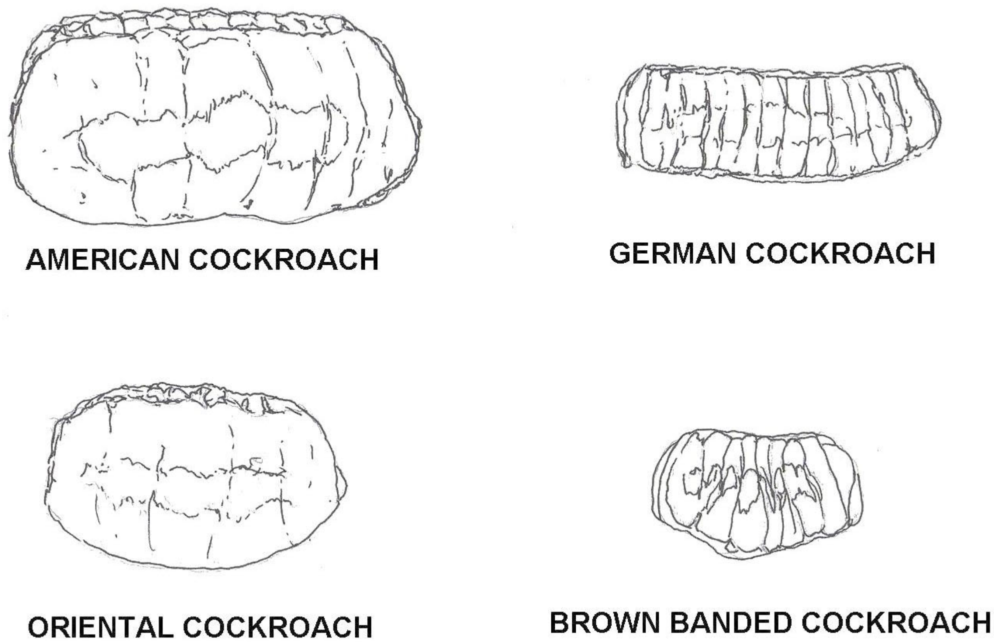
All roaches have three stages in their life cycle -- egg, nymph (young) and adult. Some have live birth and others lay eggs.

Females carry a bean-shaped egg capsule (ootheca) which is full of eggs. The newly emerged nymphs are identical to their parents except for their smaller size and lack of wings. The nymphs grow into adults by periodically shedding their skins, and may appear white for a few hours until their new skin darkens.



COCKROACH LIFE CYCLE DIAGRAM

Reproduction
Cockroaches use pheromones to attract mates, and the males practice courtship rituals, such as posturing and stridulation. Like many insects, cockroaches mate facing away from each other with their genitalia in contact, and copulation can be prolonged. A very few cockroach species are known to be parthenogenetic, reproducing without the need for males.



COCKROACH EGG TYPES DIAGRAM

Stridulation

Stridulation is the act of producing sound by rubbing together certain body parts. This behavior is mostly associated with insects, but other animals are known to do this as well, such as a number of species of fish, snakes and spiders. The mechanism is typically that of one structure with a well-defined lip, ridge, or nodules (the "scraper" or **plectrum**) being moved across a finely-ridged surface (the "file" or **stridulitrum**—sometimes called the ***pars stridens***) or vice versa, and vibrating as it does so, like the dragging of a phonograph needle across a vinyl record. Sometimes it is the structure bearing the file which resonates to produce the sound, but in other cases it is the structure bearing the scraper, with both variants possible in related groups. Common onomatopoeic words for the sounds produced by stridulation include **chirp** and **chirrup**.

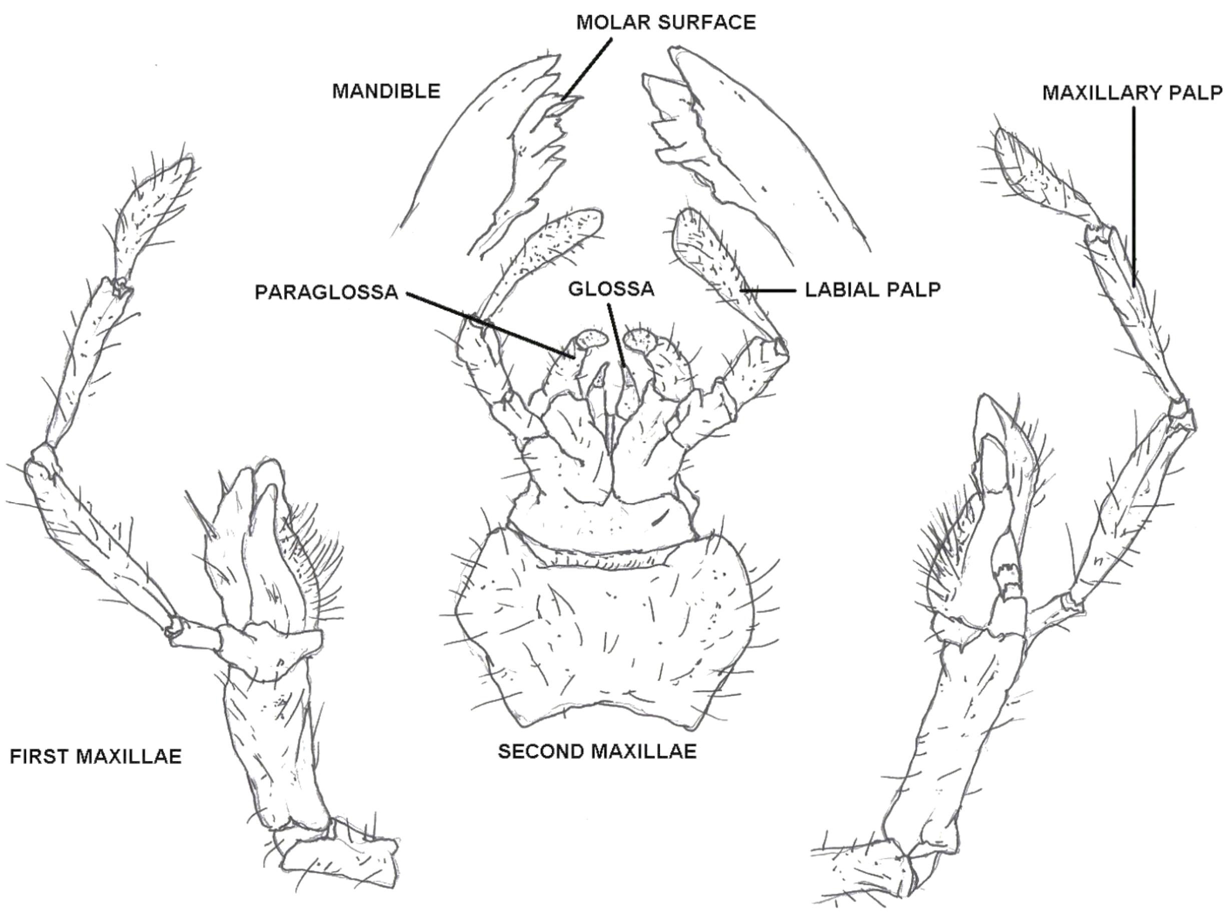
Female cockroaches are sometimes seen carrying egg cases on the end of their abdomens; the German cockroach holds about 30 to 40 long, thin eggs in a case called an ootheca. She drops the capsule prior to hatching, though live births do occur in rare instances. The egg capsule may take more than five hours to lay and is initially bright white in color. The eggs are hatched from the combined pressure of the hatchlings gulping air.

The hatchlings are initially bright white nymphs and continue inflating themselves with air, becoming harder and darker within about four hours. Their transient white stage while hatching and later while molting has led to claims of albino cockroaches.

Development from eggs to adults takes three to four months. Cockroaches live up to a year, and the female may produce up to eight egg cases in a lifetime; in favorable conditions, she can produce 300 to 400 offspring. Other species of cockroaches, however, can produce far more eggs; in some cases, a female needs to be impregnated only once to be able to lay eggs for the rest of her life.

The female usually attaches the egg case to a substrate, inserts it into a suitably protective crevice, or carries it about until just before the eggs hatch. Some species, however, are ovoviviparous, keeping the eggs inside their body, with or without an egg case, until they hatch. At least one genus, Diploptera, is fully viviparous.

Cockroaches have incomplete metamorphosis, meaning that the nymphs are generally similar to the adults, except for undeveloped wings and genitalia. Development is generally slow, and may take a few months to over a year. The adults are also long-lived, and have survived for as much as four years in the laboratory.



AMERICAN COCKROACH MOUTHPARTS (PERIPLANETA AMERICANA)

Damage

Disease Transmission. Cockroaches can carry organisms that cause human diseases, including food poisoning, dysentery and diarrhea. However, roaches have not been associated with serious disease outbreaks in the United States.

Repulsive Odor. Most cockroaches produce a secretion or chemical that has a repulsive odor. This characteristic odor can be detected in infested areas.

Allergy
Roaches can cause allergic reactions in some people. The response is caused by roach "***allergen***" that is ingested with contaminated food or inhaled when dried fecal particles and fragments of ground-up bodies of dead roaches are mixed with house dust.

Anxiety
The sight of cockroaches can cause considerable psychological or emotional distress in some individuals. Cockroaches usually do not bite, but their heavy leg spines may scratch.

Albino Cockroach
During ecdysis (the shedding of an arthropod's old cuticle) a cockroach's new cuticle is creamy white. This has resulted in many claims by novices of having discovered an albino cockroach. But the hour long ecdysial process ends with the tanning (darkening and hardening) of the new cuticle and, sadly, the 'extinction' of the 'albino' cockroach.

Cockroach Behavior Patterns

Cockroaches like humans are social insects; a large number of species are either gregarious or inclined to aggregate, and a slightly smaller number exhibit parental care for their youth.

Some scientists used to think that cockroaches aggregated because they were reacting to environmental cues, but it is now believed that pheromones are involved in these behaviors. Some species secrete these in their feces (easily found during your inspection) with gut microbial symbionts being involved, while others use glands located on their mandibles.

Pheromones produced by the cuticle enable various cockroaches to distinguish between different populations of cockroach by odor. These behaviors involved have only been studied in a few species, but German cockroaches leave fecal trails with an odor gradient. You as an applicator will learn more about cockroaches than most scientists, for you need to master cockroach control or management in a variety of situations.

Other cockroaches follow such trails to discover sources of food and water, and where other cockroaches are hiding. Thus, cockroaches have emergent behavior and patterns, in which group or swarm behavior emerges from a simple set of individual interactions.

Daily rhythms may also be regulated by a complex set of hormonal controls of which only a small subset have been understood.

In 2005, the role of one of these proteins, pigment dispersing factor (PDF), was isolated and found to be a key mediator in the circadian rhythms of the cockroach.

Pest species adapt readily to a variety of environments, but prefer warm-wet conditions found within buildings. Many tropical species prefer even warmer environments. Cockroaches are mainly nocturnal and run away when exposed to light. An exception to this is the Asian cockroach, which flies mostly at night but is attracted to brightly lit surfaces and pale colors. We will cover more on this subject later.

Cockroach Bite
The cockroach is an omnivore, that is, it eats everything edible, animal and vegetable. So if we do not move around too much while sleeping they might be inclined to nibble on our earlobes at night. They are rarely aggressive enough to attack us while we are awake.

Sounds
Some cockroach species make a hissing noise while other cockroaches make a chirping noise, similar to a bird or squirrel. Most applicators are unable to hear these sounds. The Madagascar hissing cockroach (a common pet) produces its sound through the modified spiracles on the fourth abdominal segment. Several different hisses are produced, including disturbance sounds, produced by adults and larger nymphs, and aggressive, courtship and copulatory sounds produced by adult males.

Henschoutedenia epilamproides has a stridulatory organ between its thorax and abdomen, but the purpose of the sound produced is unclear.

Cockroach Die on their Backs
Very few cockroaches die on their backs in the wild. Natural death of cockroaches probably occurs in the stomach of a bird, bat or other small animal. Second, Cockroaches are not used to living on a polished marble or vinyl floor. They are more used to a ruguous living plane including leaves and sticks and other vegetable debris. Thus when a cockroach finds itself on its back (by some mistake in its orienteering) it may have trouble righting itself if there is not debris around to grab hold of with its legs. (Try it, put a cockroach on its back on a polished floor with and without some crinkled paper.)

Third, often we come across dead cockroaches in buildings that have died of insecticide. Most of these insecticides are organophosphate nerve poisons. The nerve poison often inhibits cholinesterase, an enzyme that breaks down acetyl choline (ACh), a neurotransmitter. With extra ACh in the nervous system, the cockroach has muscular spasms which often result in the cockroach flipping on its back. Without muscular coordination the cockroach cannot right itself and eventually dies in its upside down-position.

Hardiness
Cockroaches are among the hardiest insects. Some species are capable of remaining active for a month without food and are able to survive on limited resources, such as the glue from the back of postage stamps. Some can go without air for 45 minutes. Japanese cockroach (Periplaneta japonica) nymphs, which hibernate in cold winters, survived twelve hours at 42 °F in laboratory experiments.

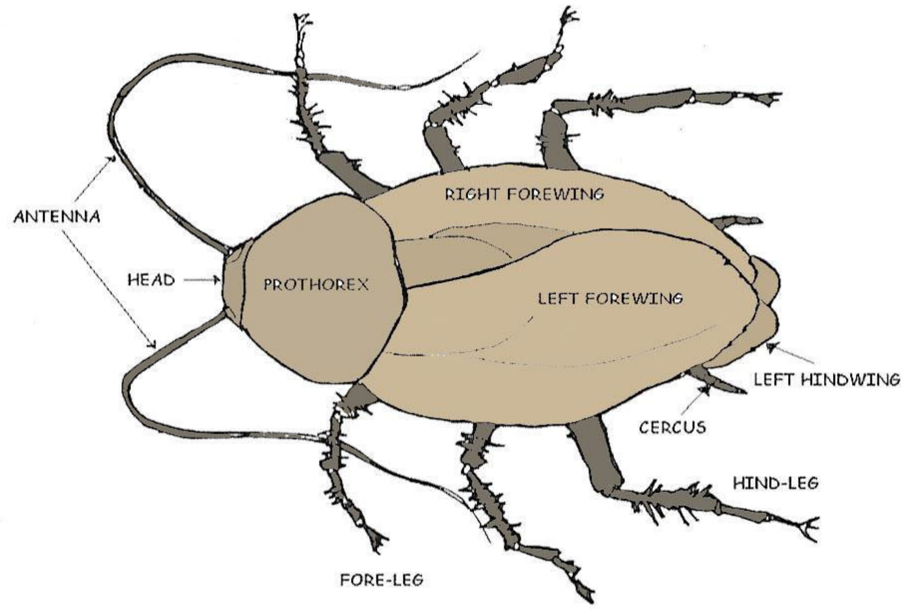
Experiments on decapitated specimens of several species of cockroach found a variety of behavioral functionality remained, including shock avoidance and escape behavior, although many insects other than cockroaches are also able to survive decapitation, and popular claims of the longevity of headless cockroaches do not appear to be based on published research.

Incredibly, the severed head is able to survive and wave its antennae for several hours, or longer when refrigerated and given nutrients.

It is popularly suggested that cockroaches will "inherit the earth" if humanity destroys itself in a nuclear war. Cockroaches do indeed have a much higher radiation resistance than vertebrates, with the lethal dose perhaps six to 15 times that for humans. However, they are not exceptionally radiation-resistant compared to other insects, such as the fruit fly.

The cockroach's ability to withstand radiation better than human beings can be explained through the design of the cell cycle. Cells are most vulnerable to the effects of radiation when they are dividing.

A cockroach's cells divide only once each time it molts, which is weekly at most in a juvenile roach. Since not all cockroaches would be molting at the same time, many would be unaffected by an acute burst of radiation, although lingering radioactive fallout would still be harmful.



COCKROACH ANATOMY DIAGRAM #1

Cockroach Digestive Tract

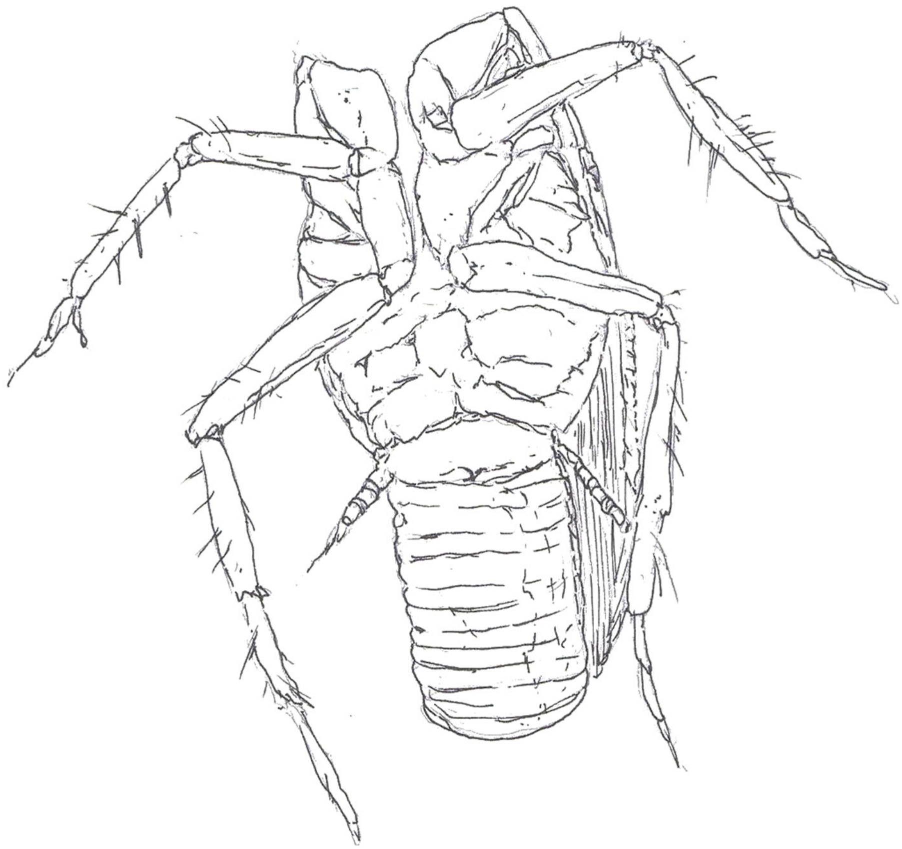
Cockroaches are generally omnivorous; the American cockroach (Periplaneta americana), for example, feeds on a great variety of foodstuffs including bread, fruit, leather, starch in book bindings, paper, glue, skin flakes, fingernails, hair, dead insects and soiled clothing. Many species of cockroach harbor symbiotic protozoans and bacteria in their gut which are able to digest cellulose. Since this is a symbiotic relationship, this with other design issues proves a designer.

In many species, these symbionts may be essential if the insect is to utilize cellulose; however, some species secrete cellulase in their saliva, and the wood-eating cockroach, Panesthia cribrata, is able to survive indefinitely on a diet of crystallized cellulose while being free of microorganisms.

Cockroaches are most common in tropical and subtropical climates. Some species are in close association with human dwellings and widely found around garbage or in the kitchen. Cockroaches are generally omnivorous with the exception of the wood-eating species such as Cryptocercus; these roaches are incapable of digesting cellulose themselves, but have symbiotic relationships with various protozoans and bacteria that digest the cellulose, allowing them to extract the nutrients.

The similarity of these symbionts in the genus Cryptocercus to those in termites are such that it has been suggested that they are more closely related to termites than to other cockroaches, and current research strongly supports this hypothesis of relationships.

All species studied so far carry the obligate mutualistic endosymbiont bacterium Blattabacterium, with the exception of Nocticola australiensise, an Australian cave dwelling species without eyes, pigment or wings, and which recent genetic studies indicates are very primitive cockroaches.



DORSAL VIEW OF COCKROACH EGG CAPSULE

Related to Termites?

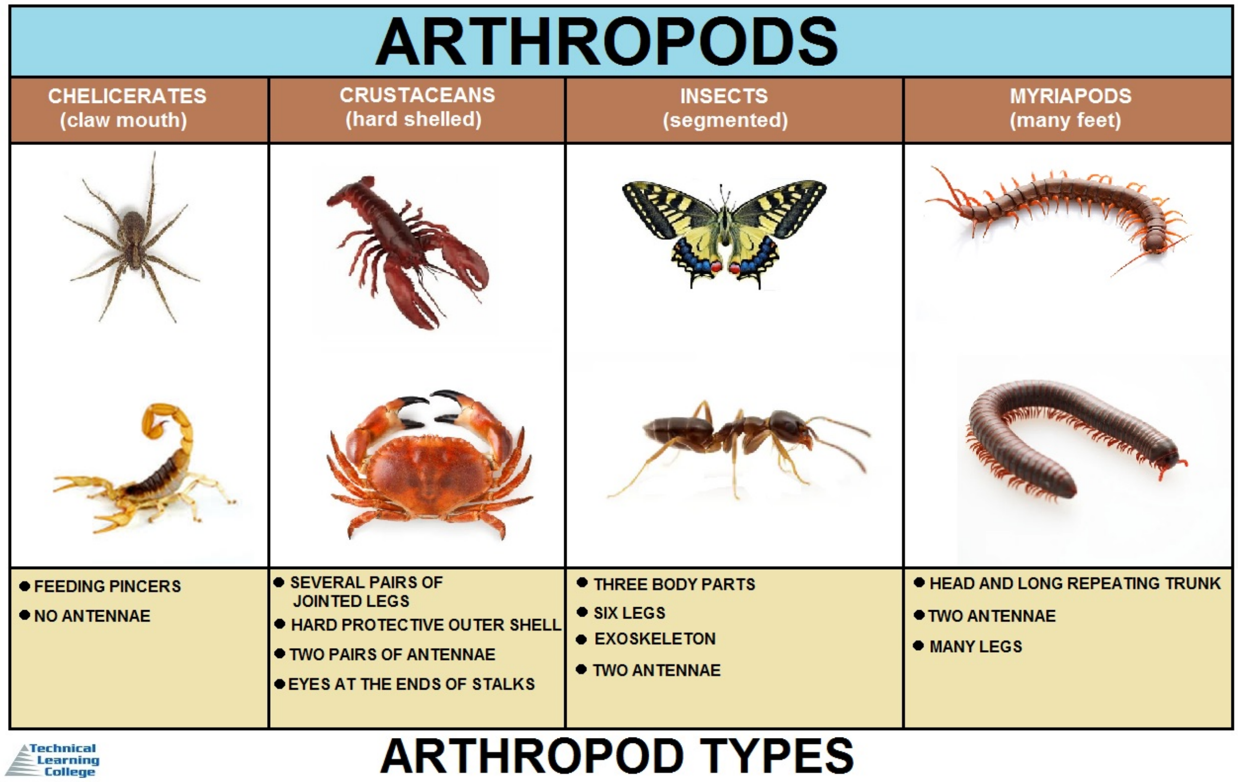
The similarity of these symbionts in the genus Cryptocercus to those in termites are such that these cockroaches have been suggested to be more closely related to termites than to other cockroaches, and current research strongly supports this hypothesis about their relationships.

Lungs and Breathing

Cockroaches, like all insects, breathe through a system of tubes called tracheae. The tracheae of insects are attached to the spiracles, excluding the head. Thus cockroaches, like all insects, are not dependent on the mouth and windpipe to breathe. The valves open when the CO_2 level in the insect rises to a high level; then the CO_2 diffuses out of the tracheae to the outside and fresh O_2 diffuses in. Unlike in vertebrates that depend on blood for transporting O_2 and CO_2, the tracheal system brings the air directly to cells, the tracheal tubes branching continually like a tree until their finest divisions, tracheoles, are associated with each cell, allowing gaseous oxygen to dissolve in the cytoplasm lying across the fine cuticle lining of the tracheole. CO_2 diffuses out of the cell into the tracheole.

While cockroaches do not have lungs and thus do not actively breathe in the vertebrate lung manner, in some very large species the body musculature may contract rhythmically to forcibly move air out and in the spiracles; this may be considered a form of breathing

Arthropod Sub-Section



Arthropods form the phylum Euarthropoda which includes insects, arachnids, myriapods, and crustaceans. The term Arthropoda as originally proposed, refers to a proposed grouping of Euarthropods and the phylum Onychophora. Arthropods range in size from the microscopic crustacean - Stygotantulus up to the Japanese giant spider crab.

Arthropods are characterized by their jointed limbs and cuticle made of chitin, often mineralized with calcium carbonate. The arthropod body plan consists of segments, each with a pair of appendages. The rigid cuticle inhibits growth, so arthropods replace it periodically by molting. Arthropods are bilaterally symmetrical and their body possesses an external skeleton. Some species have wings but roaches are not really able to fly but short distances.

Arthropods versatility has enabled them to become the most species-rich members of all ecological guilds in most environments. Arthropods have over a million described species, making up more than 80 per cent of all described living animal species, some of which, unlike most other animals, are very successful in dry environments.

Arthropod Biology
Arthropods' primary internal cavity is a hemocoel, which accommodates their internal organs, and through which their haemolymph – analogue of blood – circulates; they have open circulatory systems. Like their exteriors, the internal organs of arthropods are generally built of repeated segments.

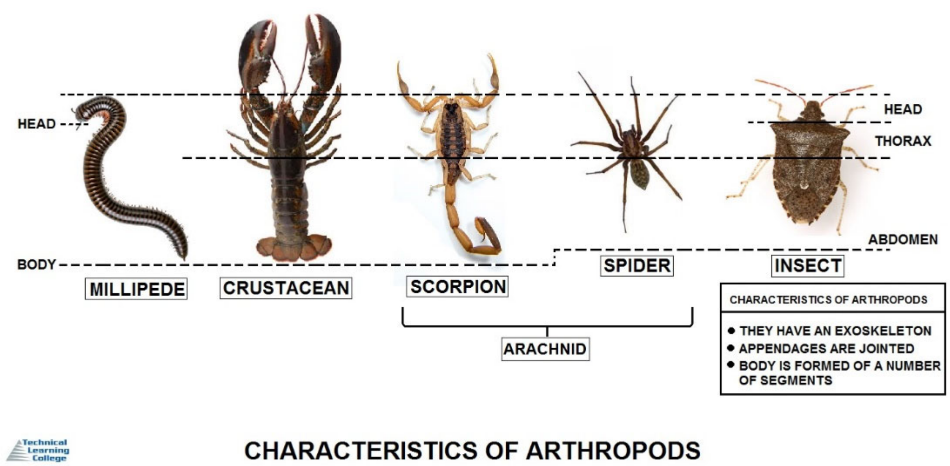
Their nervous system is "ladder-like", with paired ventral nerve cords running through all segments and forming paired ganglia in each segment. We will cover this section later in the course.

Their heads are formed by fusion of varying numbers of segments, and their brains are formed by fusion of the ganglia of these segments and encircle the esophagus. The respiratory and excretory systems of arthropods vary, depending as much on their environment as on the subphylum to which they belong.

Arthropod Vision
Arthropod vision relies on various combinations of compound eyes and pigment-pit ocelli: in most species the ocelli can only detect the direction from which light is coming, and the compound eyes are the main source of information, but the main eyes of spiders are ocelli that can form images and, in a few cases, can swivel to track prey.

Arthropod Sensor Ability
Arthropods also have a wide range of chemical and mechanical sensors, mostly based on modifications of the many setae (bristles) that project through their cuticles. Arthropods' methods of reproduction and development are diverse; all terrestrial species use internal fertilization, but this is often by indirect transfer of the sperm via an appendage or the ground, rather than by direct injection.

Aquatic species use either internal or external fertilization. Almost all arthropods lay eggs, but scorpions give birth to live young after the eggs have hatched inside the mother. Arthropod hatchlings vary from miniature adults to grubs and caterpillars that lack jointed limbs and eventually undergo a total metamorphosis to produce the adult form. The level of maternal care for hatchlings varies from nonexistent to the prolonged care provided by scorpions.



CHARACTERISTICS OF ARTHROPODS

The group is generally regarded as monophyletic, and many analyses support the placement of arthropods with cycloneuralians (or their constituent clades) in a superphylum Ecdysozoa.

Arthropods contribute to the human food supply both directly as food, and more importantly indirectly as pollinators of crops. Some species like cockroaches are known to spread severe disease to humans, livestock, and crops.

Cockroach - Insect Family Introduction

True bugs

- ✓ The true water bugs (Nepomorpha), including such insects as giant water bugs, creeping water bugs and backswimmers
- ✓ Various other true bugs insects known collectively as water bugs
- ✓ Heteroptera

Or

Cockroaches
Classification of the Blattaria

- ✓ Family Cryptoceridae -- brown-hooded cockroach.
- ✓ Family Blattidae -- oriental, American, and other cockroaches.
- ✓ Family Polyphagidae -- sand cockroaches and others.
- ✓ Family Blattellidae -- German, brown-banded, and wood cockroaches.
- ✓ Family Blaberidae -- Surinam cockroach and others.

Scientific Information
Gerromorpha
Gerromorpha is an infraorder of insects in the "true bug" order Hemiptera. These "typical" bugs (suborder Heteroptera) are commonly called semiaquatic bugs or shore-inhabiting bugs. The Ochteroidea of the true water bugs (infraorder Nepomorpha, a far more advanced lineage are also found in shore habitat, while Gerromorpha are actually most often encountered running around on the water surface, being kept from sinking by surface tension and their water-repellent legs. Well-known members of the Gerromorpha are the namesake Gerridae (water striders).

Nepomorpha
Nepomorpha is an infraorder of insects in the "true bug" order (Hemiptera). They belong to the "typical" bugs of the suborder Heteroptera. Due to their aquatic habits, these animals are known as true water bugs. They occur all over the world outside the polar regions, with about 2,000 species altogether. The Nepomorpha can be distinguished from related Heteroptera by their missing or vestigial ocelli. Also, as referred to by the obsolete name Cryptocerata ("the hidden-horned ones"), their antennae are reduced, with weak muscles, and usually carried tucked against the head.

Most of the species within this infraorder live in freshwater habitats. The exceptions are members of the superfamily Ochteroidea, which are found along the water's edge. Many of these insects are predators of invertebrates and in some cases – like the large water scorpions (Nepidae) and giant water bugs (Belostomatidae) – even small fish and amphibians. Others are omnivores or feed on plants.

Their mouthparts form a rostrum as in all Heteroptera and most Hemiptera. With this, they pierce their foodstuffs to suck out fluids; some, like the Corixidae, are also able to chew their food to some extent, sucking up the resulting pulp. The rostrum can also be used to sting in defense; some, like the common backswimmer (Notonecta glauca) of the Notonectidae can easily pierce the skin of humans and deliver a wound often more painful than a bee's sting.

Heteroptera
Heteroptera is a group of about 40,000 species of insects in the Hemiptera. Sometimes called "true bugs", that name more commonly refers to Hemiptera as a whole, and "typical bugs" might be used as a more unequivocal alternative since among the Hemiptera the heteropterans are most consistently and universally termed "bugs". "Heteroptera" is Greek for "different wings": most species have forewings with both membranous and hardened portions (called hemelytra); members of the primitive Enicocephalomorpha have wings that are completely membranous.

The name "Heteroptera" is used in two very different ways in modern classifications; in Linnean nomenclature it commonly appears as a suborder within the order Hemiptera, where it can be paraphyletic or monophyletic depending on its delimitation. In phylogenetic nomenclature it is used as an unranked clade within the Prosorrhyncha clade which in turn is in the Hemiptera clade. This results from the realization that the Coleorrhyncha are actually just a "living fossil" relative of the traditional Heteroptera, close enough to them to be actually united with that group.

The Gerromorpha and Nepomorpha contain most of the aquatic and semi-aquatic members of the Heteroptera, while nearly all of the remaining groups that are common and familiar are in the Cimicomorpha and Pentatomomorpha.

Waterbugs
"Waterbugs" is a common name for a number of aquatic insects, most of which are classified in the infraorders Gerromorpha and Nepomorpha of the order Hemiptera. The latter infraorder contains those taxa that were once known as the "Gymnocerata". Note that the term "water bug" is very often applied to some cockroaches, which are not true bugs and as Dictyoptera not even close to them (true bugs are Paraneoptera).

Selected families of Water Bugs
- ✓ Backswimmers (Notonectidae)
- ✓ Giant water bugs (Belostomatidae)
- ✓ Water scorpions (Nepidae)
- ✓ Water boatmen (Corixidae)
- ✓ Pond skaters (Gerridae)
- ✓ Smaller water strider (Veliidae)

Blattaria
Identifying characteristics for the order Blattaria include:
- Antennae long, filiform.
- Body usually flattened and oval.
- Head somewhat concealed from above by the pronotum.
- Legs long and slender, often spiny, adapted for running; tarsi 5 segmented.

Additional Information
- ✓ Many taxonomists lump cockroaches and mantids together in the order Dictyoptera.
- ✓ Perhaps no other pairing of insects seems as unlikely as cockroaches and mantids of the order Dictyoptera. Cockroaches are almost universally reviled, while mantids, also called praying mantises, are often revered. Taxonomists rely only on physical and functional characteristics to determine groups of like insects.

Compare a cockroach and a mantid, and you'll notice both have leathery forewings. Called tegmina, these wings appear roof-shaped over the abdomen. Two pairs of legs, the middle and hind sets, appear similar - long, spiny, and made for running. The feet, or tarsi, nearly always have five segments.

Dictyopterans use chewing mouthparts to consume their food. Long segmented antennae provide mantids and cockroaches with information about their environment.

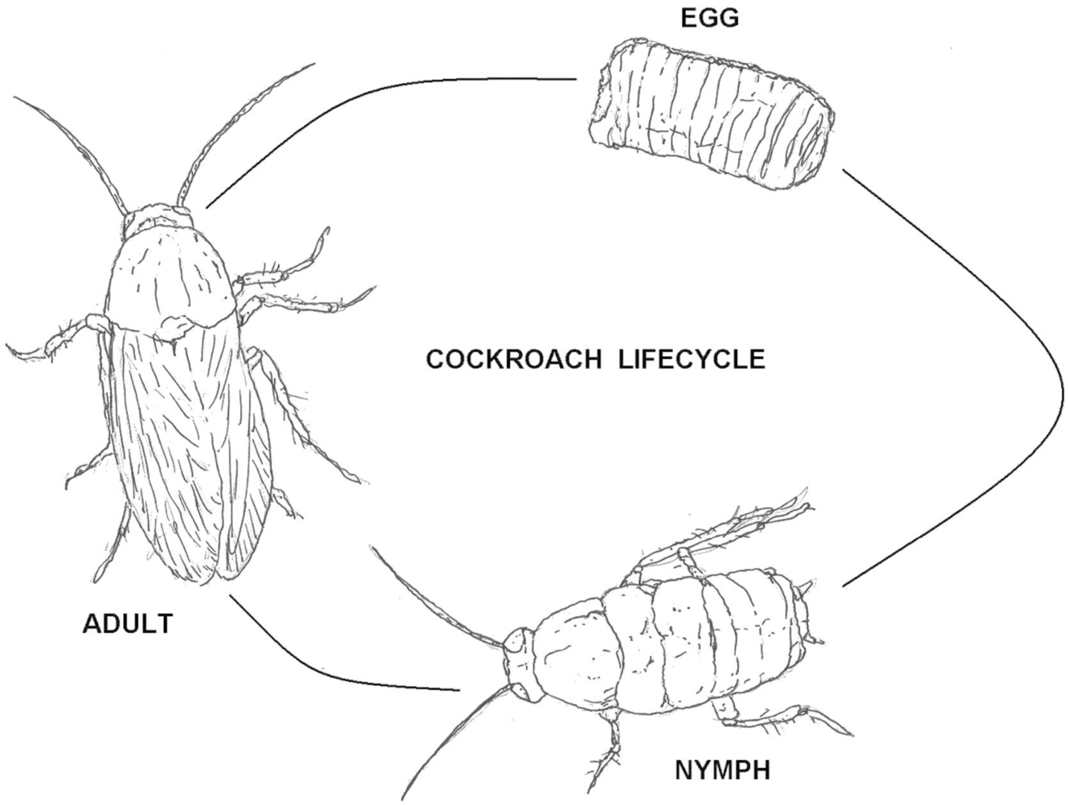
Members of this order undergo incomplete or simple metamorphosis with three stages of development: egg, nymph, and adult. The female lays eggs in groups, then encases them in foam which hardens into a protective capsule, or ootheca.

Habitat and Distribution
The order Dictyoptera contains nearly 6,000 species, distributed worldwide. With very few exceptions, mantids and cockroaches require terrestrial habitats. Most species live in tropical regions.

Major Families in the Order
- ✓ Blattidae - Oriental and American cockroaches
- ✓ Blattellidae - German and wood cockroaches
- ✓ Polyphagidae - desert cockroaches
- ✓ Blaberidae - giant cockroaches
- ✓ Mantidae - mantids

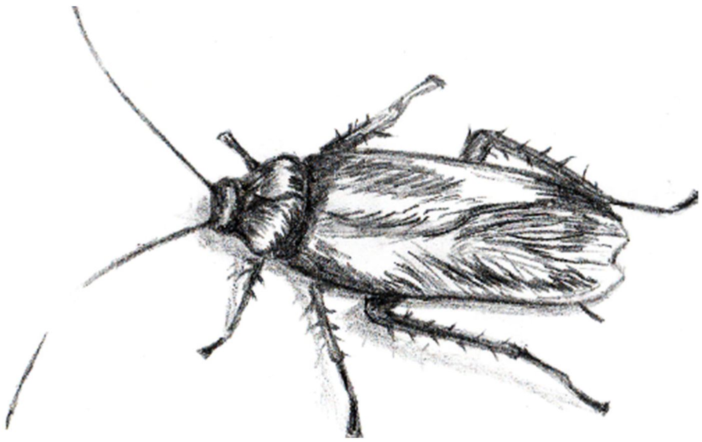
Dictyopterans of Interest
- Blatta orientalis, the Oriental cockroach, gains access to homes through plumbing pipes.
- The Brown-banded cockroach, Supella longipalpa, is called the "TV roach." It likes to hide inside warm electronic appliances.
- Brown-hooded cockroaches (Cryptocercus punctulatus) live in family groups. Females give birth to live young; the nymphs take 6 years to reach maturity.
- The Mediterranean mantid takes its scientific name, Iris oratoria from an unusual marking on the underside of its wing. Literally, the name means "talking eye," a smart description of the eyespot which is displayed when the mantid feels threatened.

Cockroaches need water as well as food, so check for condensation or leaks providing a water source. Don't forget to consider less obvious sources of water such as planters, pet water dishes and fish tanks.


EGG
COCKROACH LIFECYCLE
ADULT
NYMPH

Summary of Most Commonly Found Types of Cockroaches

There are 69 species of cockroaches in North America, but only a handful infest structures. Knowing which type of cockroach is present will assist you in knowing how to proceed. We will master the proper identification of these creatures and later we will master the control of these highly designed creatures.



AMERICAN COCKROACH

***American Cockroach (Periplaneta americana)* –** This is the largest cockroach commonly found within dwellings, measuring about 1 1/2 inches long when fully grown. It is reddish brown to brown, with a pale yellow band around the edge of the area behind the head. Adults have well-developed wings, but seldom fly. The nymphs are smaller and lack wings, but are otherwise similar in appearance. American cockroaches multiply more slowly than German cockroaches (although the smaller numbers tend to be offset by their size).

These cockroaches prefer dark, moist areas, such as in basements and crawl spaces. They often congregate in floor drains, sump pumps, pipe chases, and laundry areas, as well as boiler rooms, steam tunnels, and sewer systems. During warmer months, they can also be found outdoors in yards and around trash containers. American cockroaches often travel long distances from their aggregation sites; long-term relief requires finding and treating these areas.

***Brownbanded Cockroach (Supella longipalpa)* –** This species is far less common than the German cockroach, but occasionally can be a problem in homes. Correct identification is important because it has markedly different hiding places and habits. The brownbanded cockroach is similar in size to the German cockroach, but lacks the dark lengthwise stripes on the region behind the head. Instead, there is a black bell-shaped pattern behind the head and two transverse yellowish bands across the wings.

Brown-banded cockroaches can be found anywhere in the home and are often found in rooms other than kitchens and bathrooms. Preferred locations include upper areas of ceilings, walls, cabinets, and closets; behind picture frames and wall decorations; and beneath or inside furniture. This roach attaches its pea-sized egg capsules to hidden surfaces, such as the undersides of dressers and tables.

GERMAN COCKROACH

***German Cockroach (Blattella germanica)* –** This is by far the most common cockroach infesting homes and buildings. The pest thrives in the presence of humans but does not occur outdoors. Adults are light brown and about 1/2-inch-long, with two dark stripes running lengthwise along the shield-like area behind the head. The nymphs are smaller and darker with a tan stripe down the middle of the back.

German cockroaches reproduce very rapidly, which is one reason why controlling these pests can be difficult. A single mated female can produce thousands of new cockroaches in less than a year.

German cockroaches require warmth, moisture, and food, which is why they are most common in kitchens and bathrooms. Preferred hiding places include cracks and crevices under sinks and toilets; beneath/behind refrigerators, dishwashers, and stoves; near trash containers; and inside cabinets and pantries.

German cockroaches also congregate in clocks, toaster ovens, and other heat-producing electronic equipment. When populations are large or food is scarce, they can be found in bedrooms, closets, and other areas of the home. German roaches spend most of their time hidden in cracks and crevices, but can be quite mobile. They often travel between rooms or adjoining apartments via walls, ceilings, pipes, wires and other openings.

ORIENTAL COCKROACH

***Oriental Cockroach (Blatta orientalis)* –** The oriental cockroach is shiny black or dark brown, and the adult is about 1-inch long. The females have very short wings, and the males have wings that cover about half the abdomen. This cockroach typically infests cool, dark, damp places such as sewers, crawlspaces, cellars, and basements.

The nymphs and adults are relatively sluggish and usually occur at ground level, often living in floor drains and sump pumps. They also live outdoors under stones, debris, and plant litter, gaining entry into buildings via door thresholds, vents, and other openings. Oriental cockroaches are considered especially filthy because they often feed on garbage, human/animal waste, and decaying organic matter.

Cockroach Heat Eradication Chart	Lethal Temperature	Duration Time
German Adults	115° F	60 Minutes
German Adults	120° F	30 Minutes
German Adults	125° F	20 Minutes
German Adults	130° F	10 Minutes

WOOD COCKROACH

***Wood Cockroaches (Parcoblatta species)* –** Although the usual habitat for these cockroaches is outdoors, they often appear in homes, especially in wooded settings. The adults are about 1-inch-long and all stages are brownish in color. In some species, the outer wing margin of the adults is edged in white. Unlike the other cockroaches mentioned, male wood cockroaches are excellent fliers, and both sexes are attracted to lights.

These are primarily outdoor cockroaches, living beneath loose bark in woodpiles, fallen logs, and dead trees. They cannot survive indoors, but can be an annoyance during the spring and summer when large numbers wander in from outside. They are also brought into homes during winter in firewood. Large numbers of woods cockroaches are sometimes found nesting in rain gutters and crawl spaces.

American Roach	German Roach
Scientific Classification	
Kingdom: Animalia Phylum: Arthropoda Class: Insecta Order: Blattodea Family: Blattidae Genus: *Periplaneta* Species: *P. americana*	Kingdom: Animalia Phylum: Arthropoda Class: Insecta Order: Blattodea Family: Blattellidae Genus: *Blattella* Species: *B. germanica*
Physical Description	
They are amber colored, with a reddish-brown hue. They show the presence of a yellow plate on the back on their head that bears a mark shaped as a horizontal eight, and can grow up to 3 inches in length.	They are brownish in color, and show the presence of two vertical dark stripes on the back of their head. They can grow up to a length of 0.5 - 1 inch.
Diet	
They consume leaves, wood fragments, fungi, algae, smaller insects, and crumbs and scraps of human food.	They feed on almost anything, including things like toothpaste, paper, soap, leather, etc. They also scavenge on any human food that is left untended.
Habitat	
They prefer warm and damp outdoor habitats, with the presence of mulch. They are often found in sewers and drain pipes.	They prefer a warm and slightly damp indoor environment, and are often observed in kitchens and bathrooms.
Reproduction	
Females lay eggs within protective shells, called ootheca, in a warm and damp environment. These shells resemble capsules, and carry about 16-20 eggs at a time. In a single laying, a female will lay 9-10 of these oothecae. Once the eggs mature, the new off-springs, called nymphs, hatch from the shell. These nymphs undergo several instar stages before fully maturing into an adult. Every instar stage is marked by the occurrence of ecdysis (molting). This process may take 5-7 months to complete. In a year, a female produces up to 150 off-springs.	They are the fastest reproducing species. The female produces 3-6 oothecae, with each shell containing around 35 eggs. The eggs mature in the shells, inside the mother's body till 1-2 days before hatching. On expulsion of the ootheca from the female's abdomen, the nymphs hatch within 48 hours. Once hatched, they too undergo ecdysis and instar stages. It takes almost 3 months for the nymphs to mature into adults.

Droppings	
Their droppings are often confused with those of mice, but mice droppings show the presence of hair. The droppings of these roaches are small and blunt-ended. They also show the presence of ridges on the sides.	Their droppings are small, dark, and appear like pepper flakes. They also leave fecal stains, in the form of smears or spots, on any surface that comes in contact with it.
Odor	
Rising populations, lead to the production of a musty odor.	They also produce a musty smell.
Ability to Fly	
They can fly with ease.	They can barely fly, and are seen gliding, at best.
Lifespan	
1 to 2 years.	0.5 to 1 year.

Differences Between Male and Female Cockroaches

1. The body of male cockroach is smaller than the female.
2. The abdomen of male cockroach is slender and the last segment of the abdomen is pointed.
3. The wings of male cockroach are larger than that of the females and extend beyond the abdomen.
4. The antennae of male cockroach are smaller than that of the females.
5. In the 9th sternum of abdomen a pair of small, un-jointed anal styles and in the 10th tergum of abdomen a pair of long, palp-like jointed anal cerci are present.
6. The sternum of mesothorax is not bifurcated.

Cockroach Introduction Post Quiz

True or False

1. Cockroaches leave chemical trails in their footsteps emitting airborne pheromones for swarming and mating.

2. Immature cockroaches (nymphs) look like adults, but are smaller and do not have wings.

3. Of the six common pest species, German and brownbanded cockroaches inhabit the outdoors.

4. Females carry a bean-shaped egg capsule (ootheca) which is full of eggs.

5. Development from eggs to adults takes three to four weeks.

6. Most cockroaches produce a secretion or chemical that has a pleasant odor. This characteristic odor can be detected in infested areas.

7. Arthropods also have a wide range of chemical and mechanical sensors, mostly based on modifications of the many setae (bristles) that project through their cuticles.

8. ***Oriental Cockroach (Blatta orientalis)* –**This is the largest cockroach commonly found within dwellings, measuring about 1 1/2 inches long when fully grown.

9. ***American Cockroach (Periplaneta americana)* –** This is by far the most common cockroach infesting homes and buildings.

10. ***German Cockroach (Blattella germanica)* –** This cockroach is shiny black or dark brown, and the adult is about 1-inch long.

Cockroach Introduction Answers

1. F, 2.T, 3.F, 4., 5.F, 6.F, 7.T, 8.F, 9.F, 10.F

Topic 15 - Common Cockroach Classifications and Sub-Families

Section Focus: You will learn the cockroach scientific classification, insect order and related scientific information. At the end of this section, you the student will be able to understand and describe scientific information about the cockroach, including the arthropod family and classification. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Blattodea contains about 4000 species in at least seven families worldwide. They are hemimetabolous, dorsoventrally flattened insects with filiform, multi-segmented antennae, and mandibulate, ventrally projecting mouthparts. The prothorax has an enlarged, shield-like pronotum, often covering the head; the meso- and metathorax are rectangular and subequal. The fore wings are sclerotized as tegmina, which protect membranous hind wings folded fan-like at rest beneath the tegmina and characterized by many vein branches and a large anal lobe; wings are often reduced. Often the legs are spiny and the tarsi are 5-segmented. The abdomen has 10 visible segments, with a sub-genital plate (sternum 9), bearing in the male well-developed asymmetrical genitalia, with one or two styles, and concealing the reduced 11th segment.

PSEUNOPHORASPIS NEBULOSA

Scientific classification: Cockroaches make up the order **Blattodea**, which contains five families. The American cockroach is **Periplaneta americana**, and the Oriental cockroach is **Blatta orientalis**, both in the family Blattidae.

FAMILY BLABERIDAE

Blaberidae

Giant cockroaches or blaberids (family Blaberidae) are the second largest cockroach family. Commonly these live outside and people keep these pests as pets. 11 species in 10 genera in North America.

Blattellidae

The Blattellidae is a family of the order Blattaria (cockroaches). This family contains many of the smaller common household cockroaches, among others. They are sometimes called wood cockroaches. Comparing with other cockroach families, species in this family are usually smaller in size. In some species, the females are wingless. Most are active at night. There are many beautiful cockroaches in the family, however, the well-known pest - the German Cockroaches are also in this family.

- German cockroach Blattella germanica
- Asian cockroach Blattella asahinai
- Brown-banded cockroach Supella longipalpa
- Pennsylvania woods cockroach Parcoblatta pennsylvanica
- Parcoblatta virginica
- Parcoblatta fulvescens

Blattidae

The Blattidae is a family of the order Blattaria (cockroaches). It contains several of the most common household cockroaches. Some species in this family are of economic importance, such as the American cockroach Periplaneta americana which is an introduced pest species commonly found in and around human habitation. Species in the Blattidae family range from black and brown to red in color, but a few are even iridescent green. Some species have distinctive bands or spots, while others such as Methana marginalis have pale borders. Almost all species in the Blattidae family are flightless except for Methana species

Selected Blattidae species

- Oriental cockroach
- American cockroach
- Australian cockroach
- Brown cockroach
- Smokybrown cockroach
- Florida woods cockroach
- Common shining cockroach
- Turkistan Cockroach (Blatta lateralis) Recent Addition

Cryptocercus
Cryptocercus is a genus of Dictyoptera (cockroaches and allies) in the family Polyphagidae, of which this genus is the only member. Species are known as wood roaches or brown-hooded cockroaches. They are subsocial xylophagous insects, found in North America and Asia. There are 9 known species. Cryptocercus is especially notable for sharing numerous characteristics with termites, and phylogenetic studies have shown that this genus is more closely related to termites than it is to other cockroaches. Cryptocercus sp., apart from having a common ancestor with termites, have been placed within the Polyphagidae based on molecular analysis, and they are even closer relatives of Therea sp. (Grandcolas, 1996)

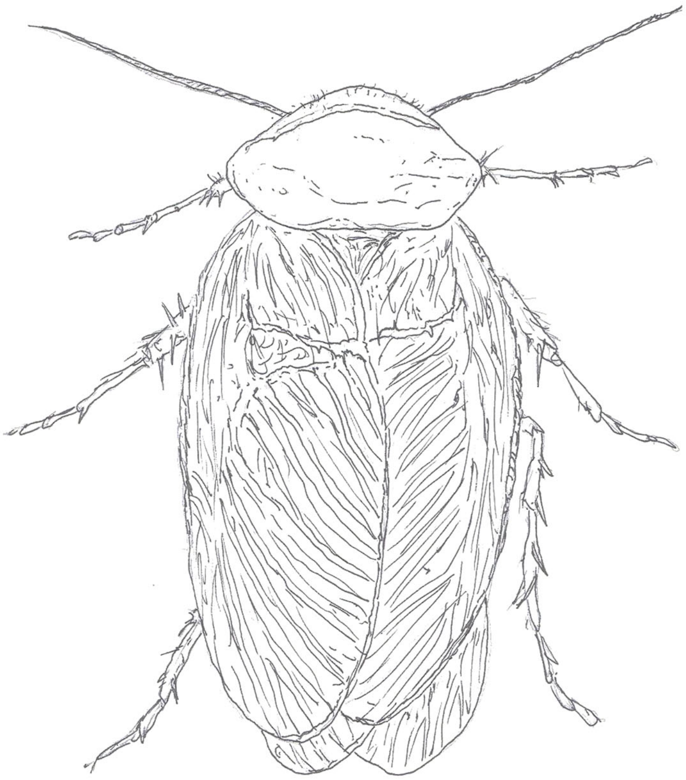
Dictyoptera
Dictyoptera includes three groups of polyneopterous insects - cockroaches (Blattaria), termites (Isoptera) and mantids (Mantodea). While all modern Dictyoptera have short ovipositors, the oldest fossils of Dictyoptera have long ovipositors, much like members of the Orthoptera. The use of the term Dictyoptera has changed over the years, and while largely out of use for much of the last century, it is becoming more widely used. It is usually considered a superorder, with Isoptera, Blattaria and Mantodea being its three orders. In some classifications, however, Dictyoptera is shifted to order status. Regardless, in all classifications the three constituent groups are the same, just treated at different rank.

Termites and cockroaches are very closely related, with ecological and molecular data pointing to a relationship with the cockroach genus Cryptocercus (Lo et al., 2000.).

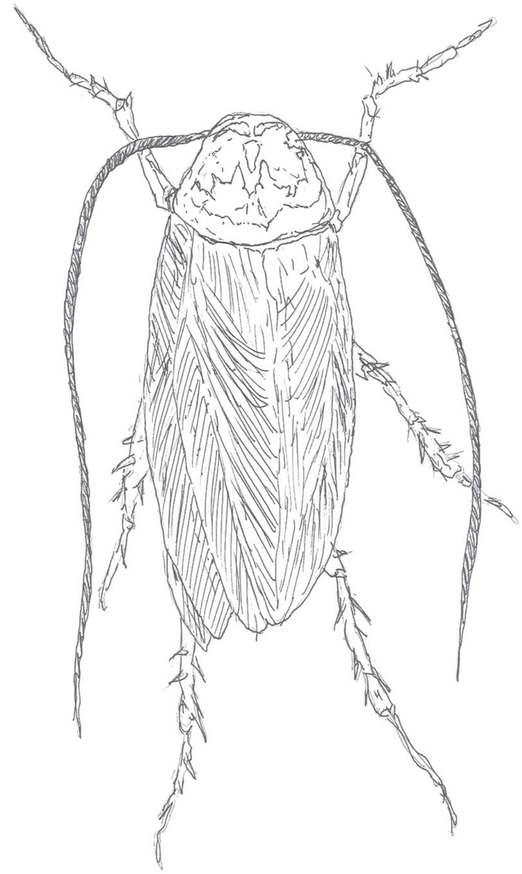
- ✓ Biting mouthparts.
- ✓ Cerci (two small appendages sticking out of the rear of the insect) are visible, and the hairs on the cercus are very sensitive to air movement in cockroaches, which explains why it is almost impossible to catch them.
- ✓ Cockroaches: about 4000 species worldwide, 130 in Europe, 9 in British Isles, but only 3 are native. Mainly nocturnal and omnivorous.
- ✓ Large or medium sized insects.
- ✓ The antennae are long, and may be longer than the entire body length.
- ✓ They can be separated into two sub orders, Blattodea (cockroaches), and Mantodea (mantids).
- ✓ They have two pairs of wings, but the front pair is leathery and held flat over the body when at rest.

Methana (Cockroach)
Species

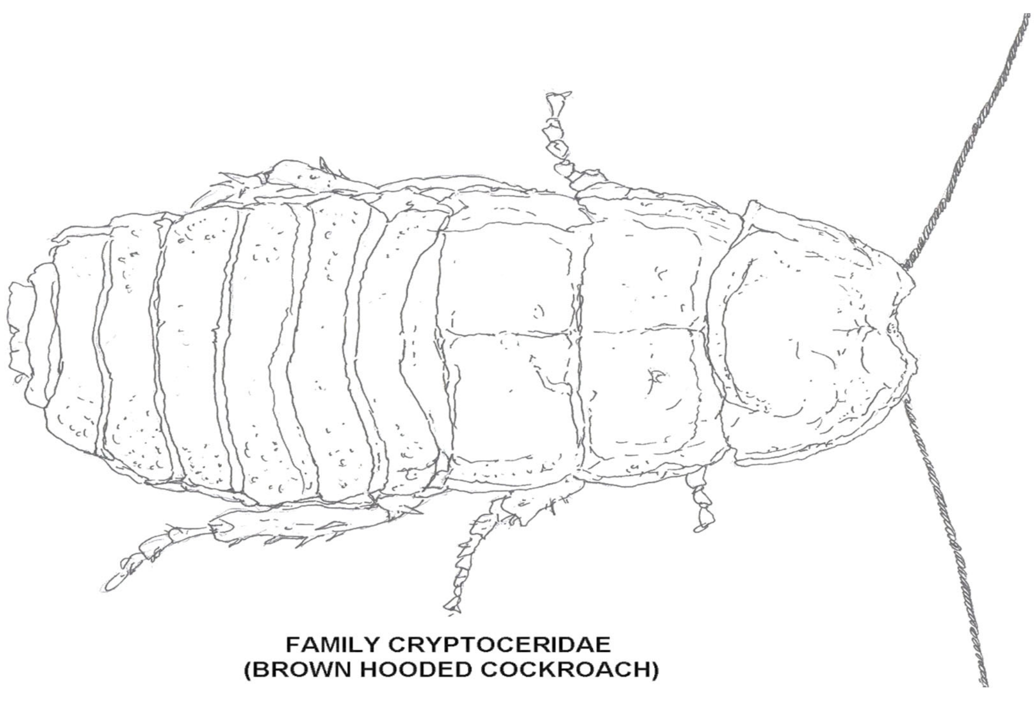
- Methana athertonensis
- Methana caneae
- Methana convexa
- Methana curvigera
- Methana hacker
- Methana marginalis
- Methana mjoebergi
- Methana papua
- Methana parva
- Methana sjoestedti
- Methana soror



FAMILY PLOYHAGIDAE



BLATTIDAE (PERIPLANETA AMERICANA)



FAMILY CRYPTOCERIDAE
(BROWN HOODED COCKROACH)

AMERICAN COCKROACH AKA PALMETTO BUG

DESERT COCKROACH

Polyphagidae (Sand Cockroaches)

Polyphagidae is a family of the order Blattaria (cockroaches). Many are known as sand cockroaches. The family is divided into five subfamilies, comprising some 40 genera. One prominent species is the desert cockroach, Arenivaga investigata.

Sewer Roaches
The American, Turkestan, Oriental cockroaches and American cockroach (Palmetto Bugs) are typically seen in damp areas, like sewers but can be seen anywhere that there is access to water. This type of roach is often seen around the perimeter of houses, sewers, basements, crawl spaces, porches, and even in your kitchen cabinets! Because these two roaches is an omnivore, it can survive just about anywhere and will feed on just about anything.

The comfortable temperature for a cockroach is about 84 degrees Fahrenheit. When temperatures are cooler, these roaches will move indoors through sewer connections, under doors, through crawl spaces, around utility pipes, air ducts, and cracks in the foundations of homes. When the temperatures rise, cockroaches can be seen more often outside on porches, and even on walkways. Many people think that because the city/sewer provider treats sewers for cockroaches, that the sewers are the only source of cockroach infestation.

The cockroach issue generally starts in dark places, like storage sheds and heavily shaded gardens, and then the cockroaches migrate to the home and hide in the drains of sinks. It is up to individuals to treat their own homes, meter boxes, storage sheds, mail boxes, dog houses and other areas cockroaches like to hide.

Here are some ways for customers to keep homes free of cockroaches:

- Don't leave food uncovered, including pet food.
- Pick up clutter. Piled up newspapers and boxes give cockroaches a good place to hide.
- Pour a little bleach down drains in your kitchen, bathroom, and shower. Cockroaches don't like the smell.
- Keep drains covered when not in use. Cockroaches love to hide there.
- Keep windows and doors closed or tightly screened to keep out all insects, including cockroaches.
- Check boxes for cockroaches before bringing them into your home.
- Treat cracks and crevices in the walls and floor, and dark areas under kitchen appliances with roach control spray or dust on a regular basis.

American Cockroach (Palmetto bug), impossible to destroy completely.

Commonly Found Cockroaches of the World

Common Pest Cockroaches

Common pest cockroaches include the American, German, Oriental, Madeira, and brown-banded. The Asian cockroach began to cause concern in the United States when it appeared in large numbers in Florida in the late 1980s. All but the American cockroach are introduced species to North America. Again, we will cover these in detail in another section.

Roaches from Around the World

In the UK the Oriental Cockroach *Blatta orientalis* is referred to as the "black beetle" due to its dark coloration. It is also called the "***mill beetle***" and the "***black clock***", probably due to its appearance at dusk in mills. In certain regions of Europe, the cockroach has been given local names which infer that the insect originates from a neighboring country, implying the neighbors are not as hygienic as themselves.

Examples for this are; "***Russe***" used in what was East Germany meaning "***Russian Cockroach***", in West Germany “***Franose***” is used, meaning "***French Cockroach***".

Many other colloquial names have arisen, in the USA around Philadelphia the Oriental Cockroach is called the "***Shad Roach***" due to its presence in high numbers at the time when Shad fish spawn in the river Delaware. "***Water bug***", "***Yankee settler***", "***Shiner***" "***Croton bug***" "***Steam-bug***" and "***Stream-fly***" are all local names for the German Cockroach in various regions of the world.

Scientific Classification

Cockroaches make up the order Blattodea, which contains five families.

The American cockroach is Periplaneta americana, and the Oriental cockroach is Blatta orientalis, both in the family Blattidae.

The German cockroach, Blatella germanica, the Asian cockroach, Blatella asahinai, and the brownbanded cockroach, Supella longipalpa, are in the family Blatellidae.

The Madeira cockroach is Leucophaea maderae, the Brazilian cockroach is Blaberus giganteus, and the Madagascar hissing cockroach is Gromphadorina portentosa, all in the family Blaberidae. The remaining families are the Cryptocercidae and the Polyphagidae.

There are 55 species of cockroaches in the United States, but only five of these are troublesome in the most States.

The Smokey Brown cockroach and the American cockroach look are similar in size and shape but the easiest way to distinguish between them is by color.

The Smokey Brown cockroach is usually dark brown to solid black in color and has no patterns on its body as an adult.

The American cockroach is a reddish-brown color and has some creamy coloration on its body right behind the head as an adult.

Adults are really the best way to tell which species you are dealing with. They can be identified because they have wings, and the immature stages do not. The immature stages are called nymphs and unfortunately the nymphs of both species look very similar. They are both a reddish-brown color until they reach adulthood.

They also have similar looking egg cases. They are both reddish-brown to black in color, and have similar looking ridges on the side.

Adult females of these species leave their egg cases in various locations to hatch. If you find an egg case that looks like a brown pellet with a zipper, you know you're dealing with large cockroaches. If the case does not have a zipper-look and has ridges that circle the case, this is a smaller cockroach and probably German cockroaches.

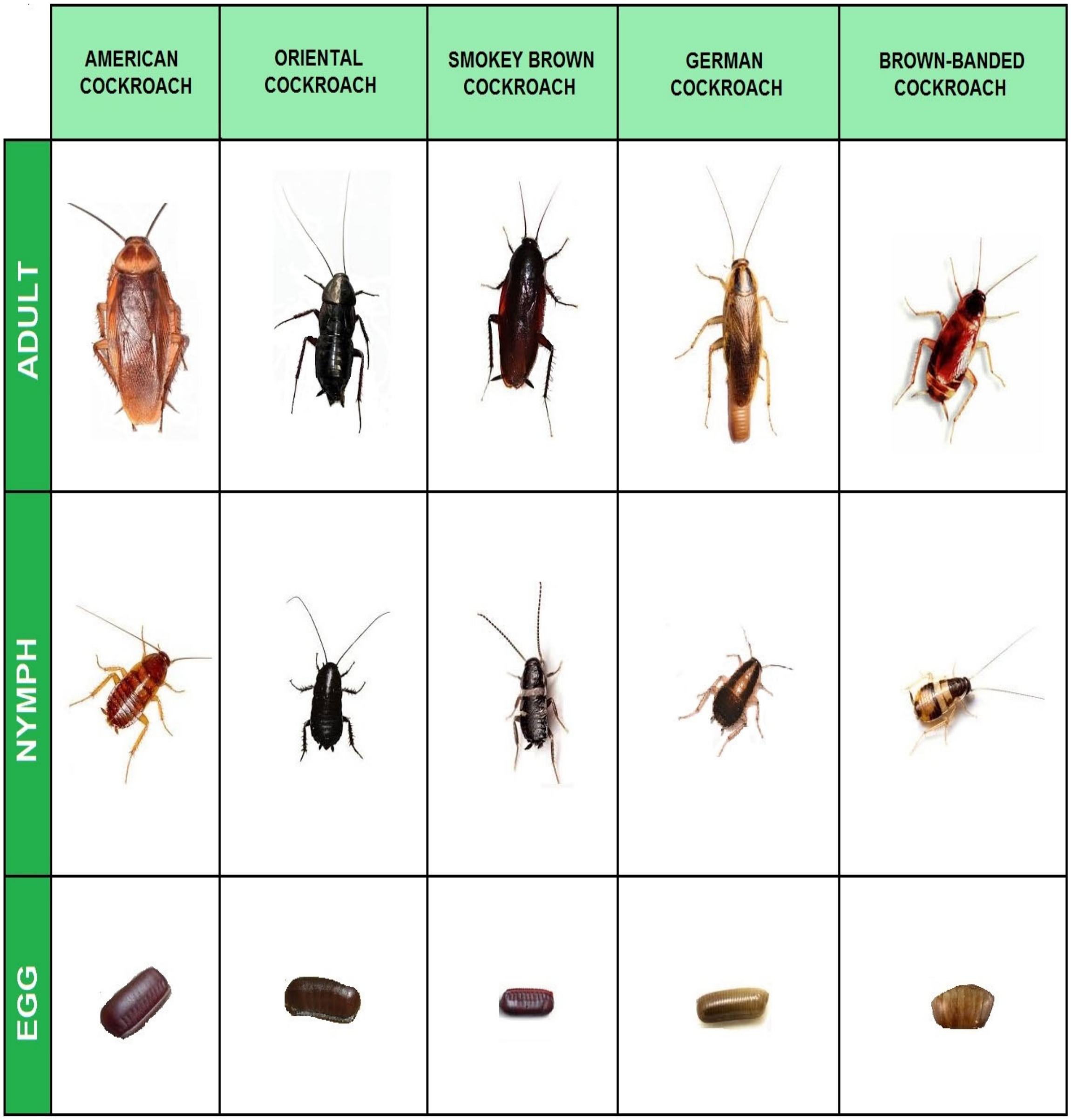
There are many smaller cockroaches that can be problematic in the southern region and they include: the German cockroach, the Asian cockroach, the Brown-Banded cockroach, and the Turkestan cockroach.

The biggest pest problems (in terms of small cockroaches) come from the German cockroach.

Interestingly enough, the German and the Asian cockroach look very similar, indeed nearly identical. They are the same size and are light brown with two dark stripes right behind their heads. The easiest way to tell them apart is that German cockroaches don't fly. When frightened, Asian cockroaches will take flight while Germans never will. For control purposes the methods are nearly the same for these two species.

Table 1. Life history of common cockroaches.

	GERMAN	AMERICAN	BROWN-BANDED	ORIENTAL	SMOKYBROWN
Average number of eggs per capsule	37	15	16	14	24
Average number of capsules per female	7	58	10	14	17
Number of molts	5-7	10 -13	7- 9	7-10	9
Nymphal stage (days)	103	468	161	542	344
Life cycle (days)	40 -251	320 -1071	143-379	215-991	311-513
Average longevity of adults (days)	140	441	115	96	247
Approximate number of offspring per year from one female under favorable conditions	35,000	812	677	196	306



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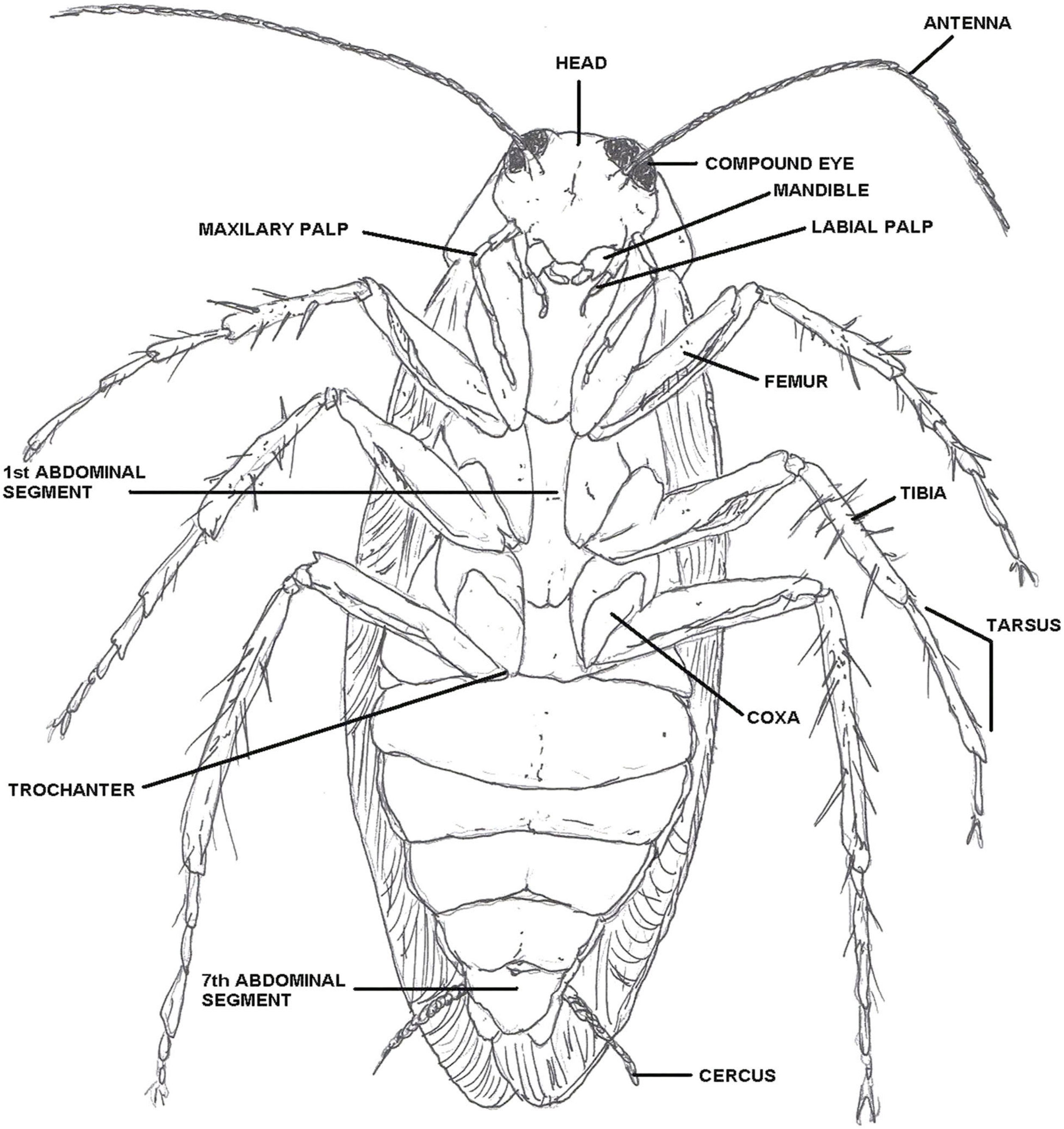
COCKROACH IDENTIFICATION



PERIPLANETA AMERICANA, VENTRAL SURFACE (FEMALE)

American Cockroaches (Periplaneta americana)

AMERICAN COCKROACH

American Cockroaches are also known as a "water bug" or "palmetto bug". American cockroaches have three developmental stages: egg, nymph, and adult. The eggs are laid in capsules that are dark brown, symmetrically shaped, and about 5/16 inch long. The female drops her egg capsule within a day after it is formed. She often drops it in a suitable location near a food source or in a protected area. Each capsule averages 14 to 16 eggs. Usually one capsule is produced each week and is often glued to a hidden surface with secretions from the female's mouth. Each female produces from 15 to 90 egg capsules.

The American cockroach is the largest of the common species, growing to a length of 1 1/2 to 2 inches. It is reddish-brown with a light yellow band around the edge of the head shield. Adults of both sexes have well-developed wings, but seldom fly. They are, however, capable of gliding flights. Nymphal cockroaches are smaller than adults, grayish-brown in color and less fully winged.

The adult female usually drops her egg capsule within a day after it is formed. She often places the capsule near a food or water source or in a location where it can be covered with miscellaneous debris. Occasionally, she glues the capsule to some surface with secretions from her mouth. The capsule may be deposited outdoors in moist wood, in cracks in bark or in whorls of plants.

American Cockroach. Adults of this species are 1 1/2 to 2 inches long. They are the largest of all the cockroaches common in the World.

Both nymphs and adults are shiny, reddish brown with a pale brown or yellow band around the edge of the head and back. The wings of both the male and female extend slightly beyond the body.

The female produces 15 to 90 egg capsules, each containing 14 to 16 eggs.

Egg capsules are deposited near a food source where the majority of eggs hatch within 60 days.

The reproductive cycle is completed in 12 to 18 months. The adult can survive 2 to 3 months without food and for a month without water.

American cockroaches are not typically found in homes; however, in commercial and industrial establishments they can be found in damp, warm basements, in furnace or boiler rooms, and storage rooms. Because of their preference for sewers and heat tunnels, they are notable as a problem in urban commercial districts.

Diet
American cockroaches feed upon a great variety of materials such as cheese, beer, leather, bakery products, starch in book bindings, manuscripts, glue, hair, flakes of dried skin, dead animals, plant materials, soiled clothing, and glossy paper with starch sizing.

The most important aspect of cockroach damage derives from the insects' habit of feeding and harboring in damp and unsanitary places such as sewers, garbage disposals, kitchens, bathrooms, and indoor storage indoors. Filth from these sources is spread by cockroaches to food supplies, food preparation surfaces, dishes, utensils, and other surfaces. Cockroaches contaminate far more food than they are able to eat.

Odorous Secretions
From various points in their bodies American cockroaches, and cockroaches in general, produce odorous secretions that can affect the flavor of various foods. When populations are high, these secretions may result in a characteristic odor in the general region of the infestation. Disease-producing organisms such as bacteria, protozoa, and viruses have been found in cockroach bodies. Different forms of gastroenteritis (food poisoning, dysentery, diarrhea, etc.) appear to be the principal diseases transmitted by these cockroaches. These disease-causing organisms are carried on the legs and bodies of cockroaches, and are deposited on food and utensils as cockroaches forage. Cockroach excrement and cast skins also contain a number of allergens, to which many people exhibit allergic responses such as skin rashes, watery eyes, congestion of nasal passages, asthma, and sneezing.

Control Methods
The best method for controlling American cockroaches is to keep them from establishing an infestation in the first place. Therefore, prevention methods are the first line of defense when dealing with American cockroaches.

Prevention (Non-Chemical)
1. Exclusion: Inspect bags, boxes, cartons, etc. for evidence of American cockroaches before they are brought into the building. Cockroach evidence includes a “roachy” odor, feces, body parts, or live cockroaches. If evidence is found, do not allow the container into the building until it is emptied and all its contents inspected.

If cockroaches are already inside the building, limit their movements from place to place by sealing around pipe chases and conduit with expandable foam. Caulk and steelwool can be used to seal cracks behind cabinetry and under sink fixtures.

Screen vents in attics and crawlspaces, install door sweeps, and weatherproof window frames. Also, trim trees and shrubs so that they do not touch the structure. In buildings that are unoccupied, flush toilets regularly to prevent American cockroaches from entering through plumbing traps.

2. Sanitation: Eliminate as many moisture sources as possible. Fix leaking pipes, store recyclables (cans and bottles) outside the structure, insulate pipes to prevent condensation, and do not leave water standing in the sink. Eliminate all cockroach food sources. Clean up spilled pet food every day. Use a vacuum attachment to remove fallen crumbs from behind the stove and between cabinets. Avoid leaving unwashed dishes on countertops, and store all food in tightly sealed containers. Rinse cans and bottles before putting them in the trash or recycling. Take the trash out every night and place it in dumpsters or receptacles with tight fitting lids. Remove clutter. American cockroaches can use storage boxes, bags, paper goods, old clothes, and magazines as places to hide. Eliminating cockroach hiding places will make the environment much less hospitable to cockroach populations.

3. Monitoring: Sticky traps can be used to detect and monitor American cockroach infestations. Sticky traps can be placed in many locations throughout a structure. The traps should be left in place at least 24 hours so they are present at night when the cockroaches are most active. Cockroaches caught in monitoring traps can let you know that there is an infestation developing. The location of the trap full that catches cockroaches will give you clues as to where the cockroaches are harboring in the structure. Keep in mind that although sticky traps can detect cockroach populations, traps cannot control them. They will not catch enough cockroaches to eliminate an infestation, so other control measures will have to be employed. Do not ever use sticky traps outdoors because they will capture non-target animals like lizards, snakes, field mice, and beneficial insects.

Treatment (Chemical) ***We will cover this more in detail in the next section.***

1. Baits: Cockroach baits consist of a toxicant (active ingredient) formulated in a food source. American cockroach baits are usually packaged as dusts, gels, pastes, or granules. Dust baits are applied into cracks, crevices, and wall voids with a bulb duster or as an aerosol formulation. Pastes and gels are usually purchased in a syringe, which can be used alone or inserted into a bait gun for more precise application. Most granular baits are applied outdoors in landscaping around the perimeter of the structure. However, some may be applied in wall voids using a bulb duster.

The most common and effective active ingredients formulated in American cockroach baits for consumer use include: hydramethylnon (Combat). and fipronil (Combat). Professional pest control products include dinotefuran (Advance), imidacloprid (Pre-empt), fipronil (MaxForce), hydramethylnon (MaxForce), indoxacarb (Advion) and acetamiprid (Transport). The advantages of using baits for American cockroach control is that baits generally have very low mammalian toxicity, and they can be placed in precise locations where they are available to cockroaches but inaccessible to people and pets.

2. Insect Growth Regulators (IGRs): IGRs for cockroach control are generally not available for homeowner purchase but are professional-use-only products. These compounds do not kill cockroaches. Instead, they disrupt the normal development of immature cockroaches making them functionally sterile as adults. The cockroach population then dies of attrition (which for American cockroaches can take over a year). Because of the slow-acting nature of IGRs, they are frequently used in combination with baits for faster control. While IGRs are certainly capable of controlling American cockroach populations, they are not commonly used for peridomestic cockroach control because the cockroaches are not breeding indoors.

However, to treat incipient populations in steam tunnels or boiler rooms, IGRs are available in spray formulations or point-source dispensers (the IGR is released on filter paper contained in a permeable plastic station and then transmigrates throughout the infested area). The most common IGRs (active ingredients) used in cockroach control products are hydroprene (Gentrol Point Source) and pyriproxyfen (Nylar).
3. Aerosol Sprays: There are a large number of consumer aerosol products available for killing cockroaches. These products will not control an infestation, but will kill individual cockroaches sprayed with the product.

Keep in mind that one two-second application of spray is enough to kill a cockroach. It may not die immediately, but it will die within a few minutes. It is not necessary to empty half a can of spray on a single cockroach until it completely stops moving.

Applying this much insecticide to a single cockroach is a pesticide contamination risk for people and pets living in the structure. Always be sure to read the product label and only apply the recommended amount of insecticide.

Treatment (Non-Chemical)
1. Inorganic Dusts: These dusts are normally applied for indoor cockroach control with a squeeze-bulb duster, which puffs the dust into cracks and crevices. Examples of these dusts are silica aerogel and boric acid. Silica aerogel is a finely ground silica (similar to glass) that adheres to the cuticle of the cockroach and absorbs the protective wax covering. This dehydrates the cockroach and eventually kills it. Boric acid dust is a stomach toxicant that also adheres to the cockroach when it walks across the dust. The cockroach then grooms itself using its mouthparts and ingests the dust in the process.

2. Captured American cockroaches can be killed by placing them in hot soapy water. The soap disrupts cockroaches' ability to close their breathing tubes and they drown in the hot water. This type of death is not instant, so do not be surprised if the cockroaches swim around for a while before dying. Be sure that the cockroaches cannot climb up and out of the water container. Stepping on the cockroaches is a quicker and equally effective method of control.

American cockroaches can be controlled outdoors with liquid insecticides or baits if you spend the time to find and target the infested sites. Persistent residual pesticides may be applied around the foundation and points of entry such as windows, doors, and utility penetrations. Once the chemical has been applied, it is best to seal cracks, crevices, and holes on the building to enhance long-term control.

Bait Formulations
Bait formulations of a variety of slow-acting chemicals are widely used for cockroach control indoors and outdoors. Bait formulations include liquids, pastes, gels, and granules; often the bait is housed in a station. Baits can provide effective control, but the cockroaches must preferentially feed on the baits rather than existing food sources. Hence, it is particularly important to employ sanitation measures (see above) when using cockroach baits.

Asian Cockroach (*Blattella asahinai)*

ASIAN COCKROACH (ADULT)

The Asian cockroach was identified as a newly introduced species to the United States in 1986 when a professional pest control operator collected these insects in Lakeland, Florida. He referred to them as German cockroaches, *Blattella germanica* (L.), but noted that their behavior was unlike any other German cockroaches that he had previously encountered. Upon further investigation the cockroaches were found to be *B. asahinai*, Asian cockroaches.

Distribution and Habits

The Asian cockroach was first described in 1981 from insects collected on Okinawa Island, Japan. It is most likely that *B. asahinai* was introduced into the United States through imports from Japan. Since the first identification of *B. asahinai* in Lakeland (Polk County), it has been reported from Marion County in central Florida to Broward County in southwest Florida.

The primary habitat of the Asian cockroach is outdoors in shaded mulched or composted areas, such as landscaping and gardens, where fresh plant litter accumulates. Populations of 30,000 to 250,000 insects per acre have been reported. Members of this species are strong fliers, unlike their close relative, the German cockroach. They may invade structures but indoor infestations are rare occurrences.

They become active at sundown and are attracted to light-colored surfaces and brightly lit areas. Adults will take flight during the day if disturbed. The presence of this pest is obvious since their peak activity period coincides with our leisure time.

ASIAN COCKROACH (LOOKS LIKE A GERMAN COCKROACH)

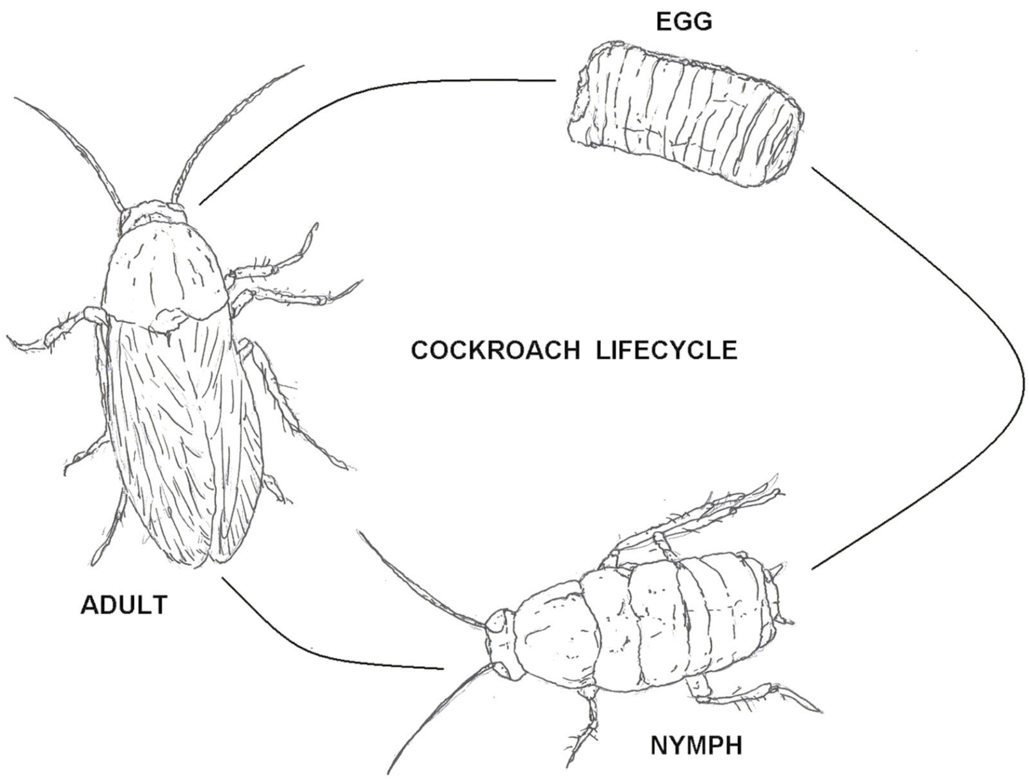
Description

Asian cockroaches are almost identical to German cockroaches. Chemical analysis by gas chromatography will confirm the species. However, there are also slight morphological differences between *B. asahinai* and *B. germanica*. Asian cockroach adults have longer and narrower wings than those of German cockroaches.

There are also differences between the species in the shape of the male tergal glands. Asian cockroach females produce smaller egg capsules and nymphs are smaller than that of German cockroaches. Asian cockroach first instars have 23 antennal segments while German cockroach first instars have 24 to 25. Finally, margins of the abdomen and spots along the abdominal midsection of *B. asahinai* late instars appear white, whereas those areas are lightly pigmented in *B. germanica*.

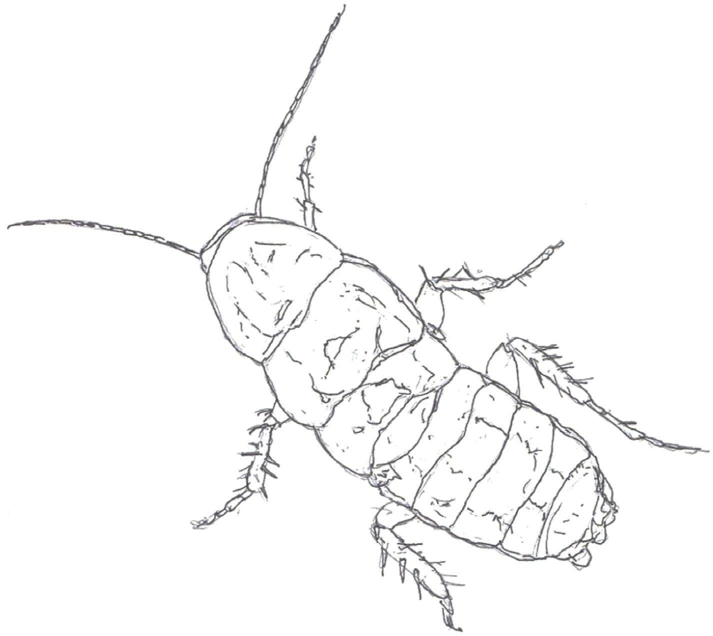
Asian Cockroach Life Cycle

Female Asian cockroaches have a lifetime reproductive potential for producing approximately four egg capsules, each averaging 37 nymphs. Immatures take approximately 67 days to reach adulthood. Females can then live for 104 days and males can live for 49 days. Females can produce their first egg capsule 13 days after adult eclosion, and can drop another 20 days later. Adults are abundant February through May and again August through September. Nymphs predominate May through August.

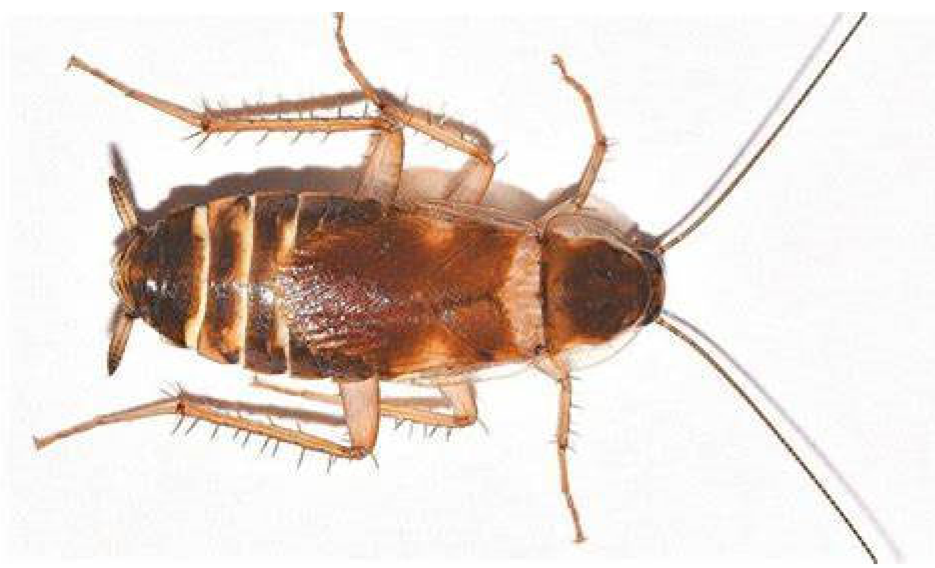


Asian Cockroach Management
Control of Asian cockroaches is difficult due to their mobility and abundance of population sites. Traditional treatments using residual sprays inside and around the perimeter of a structure are ineffective due to numerous infestations in mulched and wooded areas.

Plus, adults enter homes through windows and doorways, avoiding areas typically treated for control of German cockroaches. Sodium vapor lamps for security lighting and yellow incandescent bulbs for porch lighting are both less attractive to adults and would thereby reduce attraction of adult insects to lighting near buildings. Although Asian cockroaches are susceptible to all pesticides, toxic pelletized baits scattered outdoors have provided the most reliable control.



BROWN HOODED COCKROACH



BROWN – BANDED COCKROACH

Brownbanded Cockroach (*Supella longipalpa*)

Both nymphs and adults of this species are light brown and can be distinguished easily by the presence of two angled or transverse bands across the base of the wings and abdomen. Adult males are 1/2 to 5/8 inch long; the female is slightly shorter. Though both have wings, only the male can fly.

BROWN – BANDED COCKROACH

The female carries each egg capsule for only a day or two before attaching it to a protected surface. The egg capsules are usually deposited in clusters or rows, and most of the eggs hatch within 50 days. Approximately 5 to 18 egg capsules are produced per female, each containing 19 eggs. About 3 to 9 months are required to complete the reproductive cycle.

Brownbanded cockroaches prefer a dry, warm environment. They are generally found on ceilings, high on walls, and in light switches, closets and furniture. In some places they are known as "***TV roaches***" because of their frequent presence in living-room furniture and appliances.

The wings of adult males cover their abdomens, while the females' wings are shorter. The yellow bands across the back are more pronounced on nymphs than on adults. These cockroaches are quite active, and the adults, especially the males, fly rapidly when disturbed. Both adults and nymphs may jump to escape danger.

Brownbanded Cockroach Adult Female
The adult female carries her egg capsule for only a day or two before gluing it to a protected surface underneath or inside furniture, in a closet or on the ceiling in a darkened room. They can also be found in televisions and other appliances.

Brownbanded cockroaches are more apt to be found in homes, apartments, hotels, motels, nursing homes and hospitals than in restaurants, grocery stores and other commercial establishments. They prefer starchy foods and appear to have lower water requirements than other cockroaches.

They can occupy drier locations within a building. Nymphs and adults frequently are found on ceilings in dark or dimly lit rooms, behind picture frames, in light switches, in upper walls of cabinets and closets, or on undersides of furniture and inside upholstered furniture. Because brownbanded cockroaches are found in so many locations they may be more difficult to control.

Starchy Food
Brownbanded cockroaches prefer starchy food (e.g., glue on stamps and envelopes), are often found in offices and other places where paper is stored, and are more common in apartments or homes that are not air conditioned. They also infest animal-rearing facilities, kitchens, and hospitals. Adult males sometimes fly when disturbed, but females do not fly. Females glue light brown egg cases, which are about ¼ inch long, to ceilings, beneath furniture, or in closets or other dark places where eggs incubate for several weeks before hatching. Each female and her offspring are capable of producing over 600 cockroaches in one year. The brownbanded cockroach feeds on a wide variety of materials. Like members of other cockroach species, it may consume materials like glue or paste (especially from animal-based materials), starch, and certain color dyes. As a result, items like stamps, envelopes, bindings of older books, draperies, and occasionally wallpapers may show signs of feeding.

Nonfood Materials
This species has also been known to chew on nonfood materials, such as nylon stockings, presumably for the residues of body oils and skin flakes. Damage by brownbanded cockroaches results from their feeding and harboring in pantries and storage areas indoors. Also, bacteria and protozoa that cause diseases (such as different forms of gastroenteritis and diarrhea) can be carried on the legs and bodies of cockroaches and deposited on food, utensils, etc.

Odorous Secretions
Cockroaches in general produce odorous secretions from various points in their bodies. Such secretions can affect the flavors of various foods. When cockroach populations are high, these secretions may result in a characteristic odor in the general region of the infestation. Disease-producing organisms such as bacteria, protozoa, and viruses have been found in their bodies. Different forms of gastroenteritis (food poisoning, dysentery, diarrhea, etc.) appear to be the principal diseases transmitted by cockroaches. The insects carry these disease-causing organisms on their legs and bodies and deposit the organisms on food and utensils as they forage. Cockroach excrement and cast skins also contain a number of allergens, to which many people exhibit allergic responses such as skin rashes, watery eyes, congestion of nasal passages, asthma, and sneezing.

Brownbanded Cockroach Management Strategies

Survey *We will cover this more in detail in the next section.*
To control brownbanded cockroaches, it is important to do a thorough inspection, or survey. Cockroach surveys involve placing sticky traps at strategic locations within the building. Whenever possible, place survey traps either against a wall or in a corner of the floor, a shelf, or a drawer. Most commercially available traps come complete with bait to encourage cockroaches to enter. One week of trapping with a sufficient number of trap sites (ten or more) usually provides enough information for effective control. Treatments should be directed to those areas where cockroaches have been collected in the traps.

Sanitation, Structural Modifications, and Repairs
Brown banded cockroaches are carriers of pathogens and can contaminate food with certain bacterial diseases that result in food poisoning, dysentery or diarrhea. Some homeowners are allergic to Brown banded cockroaches; some health experts have claimed that the inhalation of feces and body fragments have caused an increase in asthma cases, especially in inner-city children.

In controlling brown banded roach infestations, it is helpful to seal cracks and holes behind toilets and around plumbing pipes under sinks. Also, do not store cardboard boxes and paper bags under sinks or in the kitchen or bathroom since they tend to congregate in them. Inspect stored food containers, appliances and used furniture for egg cases that may be brought into the home. It is difficult to keep cockroaches from entering the home via boxes, grocery bags, suitcases, etc., but you can prevent them from developing into a serious problem. One of the key factors is sanitation. Clean up spilled foods on the floor. Do not leave dirty dishes overnight. Store items such as cereal, crackers, and cookies in airtight containers. Empty garbage each evening into a sturdy container with a tight-fitting lid.

Brown-banded cockroaches can conceal themselves in many places that are inaccessible to larger species. Making structural modifications such as caulking (in cracks, crevices; around ducts, molding, etc.) is necessary in bedrooms, bathrooms, dining rooms, and other areas of the house.

Chemical Control
Baiting is an effective method to control or eliminate brownbanded cockroaches. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin can provide a high level of control when applied to those areas where cockroaches harbor. Some formulations of baits are available to the public in plastic feeding stations.

Professional pest control personnel also have cockroach baits in flowable granular and gel formulations. Care should be taken to closely follow the label instructions for use.

Insecticidal dusts like boric acid, silica aerogel, and diatomaceous earth can provide additional control. Apply dusts lightly, as heavy deposits may repel cockroaches. These products can be applied in the cracks and crevices of bureaus, clothes closet shelves, ceiling light fixtures, valances above windows, hollow legs of chairs and tables, and wall or floor cracks and crevices throughout the house.

Do not place dusts where they could come in contact with children or pets. Do not allow children access to areas treated with boric acid. Boric acid is of low toxicity to adults, but it can present a hazard to children. Take precautions to assure that dusts do not contaminate food. The use of residual insecticidal sprays or aerosol foggers within a structure is of little value in controlling brownbanded cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy.

Control Brownbanded Cockroaches

1. For indoor infestations, spray Suspend SC all along the baseboards, window and door frames, and underneath appliances using a handheld sprayer. Repeat this treatment every two to three months.
2. Dust underneath baseboards and inside wall voids with Delta Dust.
3. Outdoors, use a residual spray such as Talstar One or Cynoff WP outside around all points of possible entry including windows and door frames, dryer vents, and pipe openings. Use the same residual indoors along baseboards and framed entry points.
4. Recommended baits for Brownbanded roach control include Advion Roach Bait Gel and Maxforce Roach Bait Stations. Each roach feeding on Maxforce Roach Gel can kill up to 40 other roaches via droppings and dead bodies.

Cockroaches need water as well as food, so check for condensation or leaks providing a water source. Don’t forget to consider less obvious sources of water such as planters, pet water dishes and fish tanks.

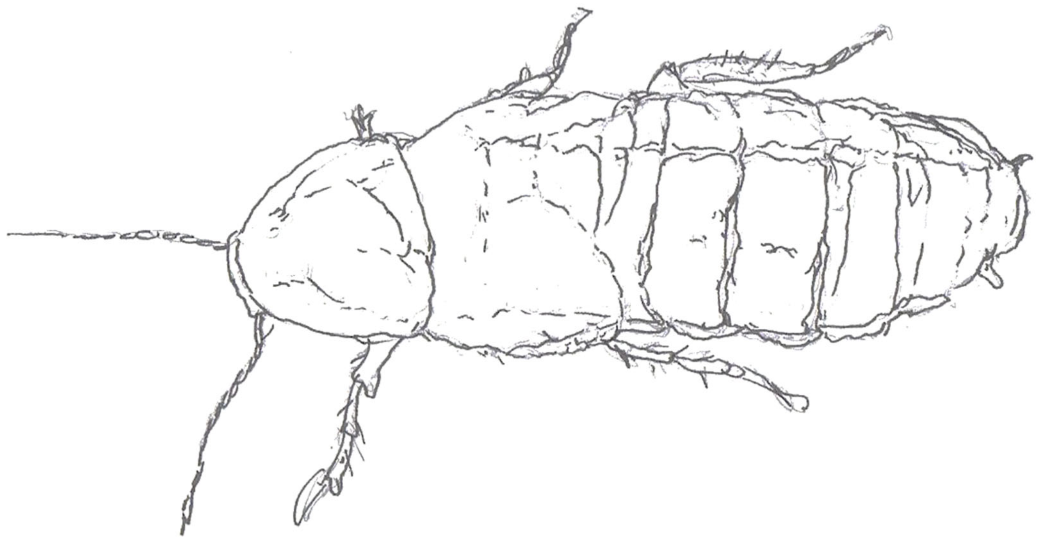
Blaptica dubia, the **Dubia roach**

BLAPTICA DUBIA (COMMON PET)

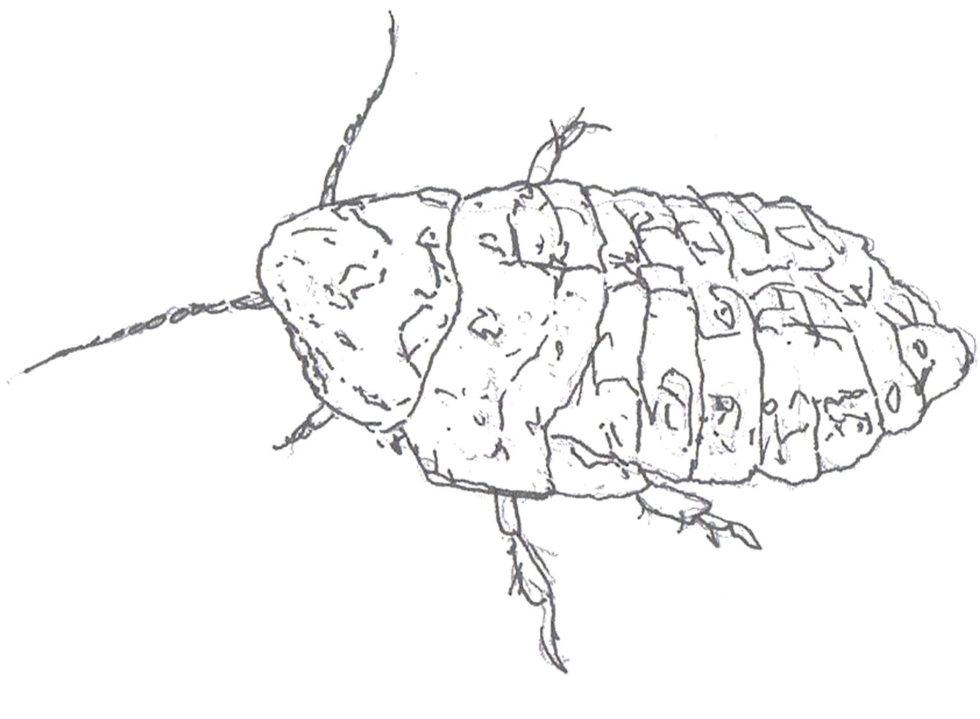
Blaptica dubia, the **Dubia roach**, also known as the **orange-spotted roach**, **Guyana spotted roach**, or **Argentinian wood roach**, is a medium-sized species of cockroach which grows to around 40–45 mm (1.6–1.8 in). They are sexually dimorphic; adult males have full wings covering their body, while females have only tiny wing stubs, their tegmina (forewings) being around a fourth of their body length.

Adults are dark brown to black with somewhat lighter orange spot/stripe patterning sometimes visible only in bright light. Coloration does differ slightly with environment and diet from one colony to another.

Blaptica dubia are partially ovoviviparous, giving birth to live young after eggs hatch inside the female, and can give birth to 20 to 40 nymphs per month under favorable conditions. The Dubia cockroach is found in Central and South America, beginning in Costa Rica. It is common from French Guiana and Brazil to Argentina.

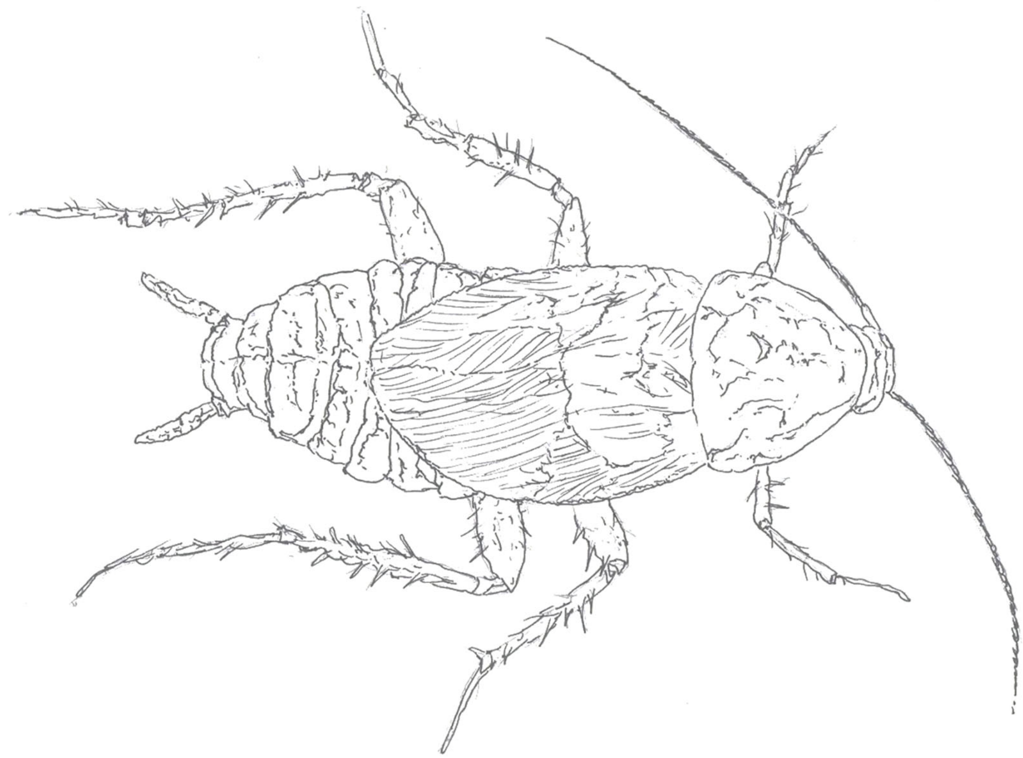


BLAPTICA-DUBIA COCKROACH – FEMALE



BLAPTICA-DUBIA COCKROACH - JUVENILE

Brown-Hooded Cockroach (Cryptocercus)



BROWN-BANDED COCKROACH

Cryptocercus is a genus of Dictyoptera (cockroaches and allies) in the family Polyphagidae, of which this genus is the only member. Species are known as wood roaches or brown-hooded cockroaches. They are subsocial xylophagous insects, found in North America and Asia. There are 9 known species.

Cryptocercus is especially notable for sharing numerous characteristics with termites, and phylogenetic studies have shown that this genus is more closely related to termites than it is to other cockroaches. Cryptocercus sp., apart from having a common ancestor with termites, have been placed within the Polyphagidae based on molecular analysis, and they are even closer relatives of Therea sp. (Grandcolas, 1996 and later). Cryptocercus cockroaches occur in Oregon and Northern California, as well as pockets of the SE USA (excluding Florida).

They are rarely encountered as colonies of them live in and feed on rotting logs. They are seldom offered to the pet hobby. Cockroaches nutritionally benefit from a substrate of mixed organic matter. The pair feed their offspring for several months after hatching. They inhabit moist, forested areas and are related to termites.

Exterior Treatments
Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels.

Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair. Changing white incandescent bulbs to yellow bulbs around entrance doors may help.

Chemical Control
Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior.

Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application. The use of residual sprays or aerosol foggers within a structure is of little value in controlling cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy.

Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.

Cuban Cockroach (*Panchlora nivea*)

CUBAN COCKROACH

Looks similar to a German, but has a beautiful green color.

The Green banana cockroach (Panchlora nivea) is a small species of cockroach that is found in Cuba and the Caribbean, and along the gulf coast from Florida to Texas and has been observed as far north as Charleston, South Carolina. It is also called the Cuban cockroach. It prefers subtropical or tropical climates and is currently not found beyond these areas. It is usually an outdoor species and is rarely found indoors and thus is not considered a pest. The adults can often be found in shrubbery, trees, and plants. The young can be found under logs and other debris. It is often attracted to bright lights and it is mainly a nocturnal species. It is often a popular pet roach due to its relatively pleasant green color and the fact it is not an invasive indoor species.

The females can grow up to 24 mm and the smaller males are 12 to 15 mm long. It is winged and a strong flier. They are light green in color with a yellow line running up the sides. The adults love to climb. The nymphs are brown or black in color and are burrowers.

Cuban (Green Banana) Cockroach Habitat

The Cuban cockroach, also called the green banana cockroach, is an outdoor tropical species. They can be found in woodpiles, shrubbery, trees, and plant leaves. Nymphs can be found in leaf litter and debris. Cuban roach encounters are likely to occur in homes in rural, wooded areas.

Control

Since Cuban cockroaches are attracted to light and are also good fliers, keeping outdoor lights off when not in use, as well as using lower-wattage light bulbs, may help to discourage their presence. Scattering wood, lumber and leaf or debris piles will also keep this, and many other, cockroach species from nesting.

Cuban (Green Banana) Cockroach Control
Controlling this roach is normally straightforward and fairly simple. Desiccant dusts and a good baiting system are usually sufficient to gain good control. The sprays and dusts used with success against household cockroach species are of very limited benefit against roaches. Exclusion techniques that prevent roach entry should be considered.

Doors and windows should be tightfitting and cracks, gaps and other possible entry points should be sealed. If a breeding site can be moved or modified (e.g., relocating a wood pile farther from the house) it might help. Also, store firewood outdoors until you are ready to burn it.

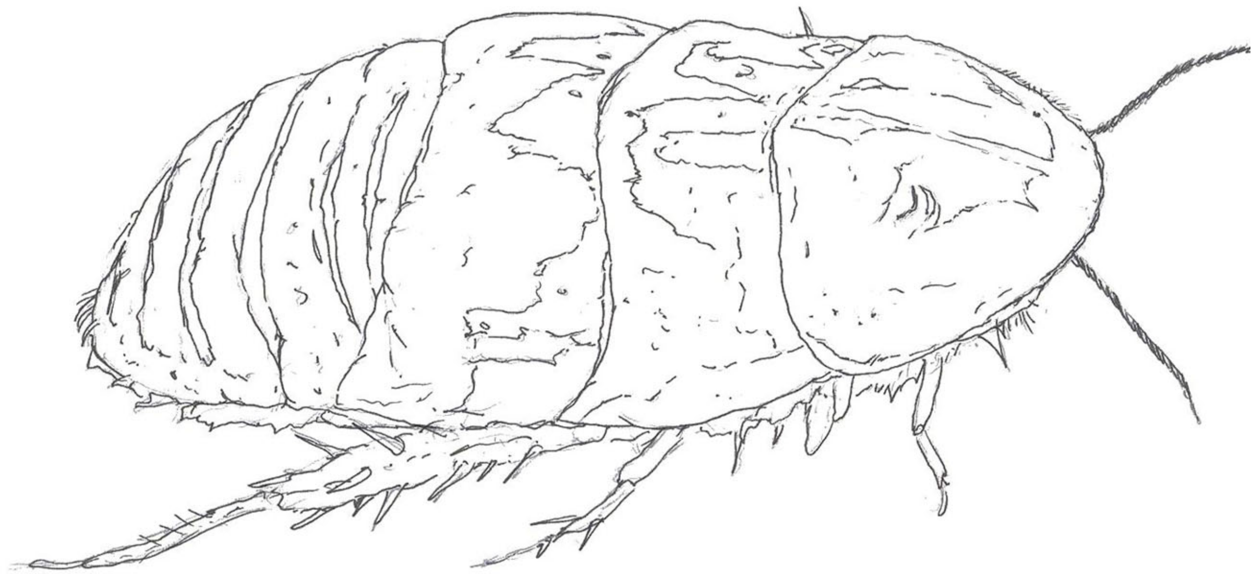
The males are attracted to lights at night and limiting porch light use in late May through June when males are flying might be of some benefit. Outdoor insecticide barrier treatments around windows and doors and along the foundation. Direct application of insecticide to firewood does no good and is discouraged. Cockroaches inside need only be picked up discarded.

Cuban (Green Banana) Cockroach Chemical Control
As breeding populations rarely become established indoors, house interiors should not be treated. Treat exteriors only when cockroaches enter homes from the surrounding environment.

Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair.

Desert Cockroach (Arenivaga genitalis), (Arenivaga investigata)



DESERT COCKROACH

Males are 18-20 mm (¾") long and have a delicate brown-on-tan pattern on the pronotum. The wings are a mottled tan and longer than the abdomen. Females are 12-14 mm (½") long and have a broadly oval, somewhat hump-backed appearance. Females are wingless and may resemble dark brown sow bugs to the untrained eye. Recognizable by its cockroach shape, but not by its habits. Males are nocturnal and are strongly attracted to lights. They seldom enter homes unless doors are open and lights are left on. Females spend their lives burrowing in soft soil where they feed on organic debris. They are typically associated with pack-rat or other desert rodent burrows where the soil has been loosened and organic material is abundant.

The desert cockroach, Arenivaga investigata, can gain weight by absorption of water-vapor from unsaturated atmospheres above 82.5% relative humidity. Blocking the anus or the dorsal surface with wax does not prevent water vapor uptake, but interference with movements of the mouthparts or blocking the mouth with wax-prevents such uptake. Weight gains are associated with the protrusion from the mouth of two bladder-like extensions of the hypopharynx.

During absorption these structures are warmer than the surrounding mouthparts, their surface temperature increasing with relative humidity. This suggests that the surfaces of the bladder-like structures function at least as sites for condensation of water vapor, but the precise location of its transfer into the hemolymph has not yet been identified.

Desert Cockroach Control
Controlling this roach is normally straightforward and fairly simple. Desiccant dusts and a good baiting system are usually sufficient to gain good control. The sprays and dusts used with success against household cockroach species are of very limited benefit against roaches. Exclusion techniques that prevent roach entry should be considered.

Doors and windows should be tightfitting and cracks, gaps and other possible entry points should be sealed. If a breeding site can be moved or modified (e.g., relocating a wood pile farther from the house) it might help. Also, store firewood outdoors until you are ready to burn it. The males are attracted to lights at night and limiting porch light use in late May through June when males are flying might be of some benefit. Outdoor insecticide barrier treatments around windows and doors and along the foundation. Direct application of insecticide to firewood does no good and is discouraged. Cockroaches inside need only be picked up discarded.

Desert Cockroach Chemical Control
As breeding populations rarely become established indoors, house interiors should not be treated. Treat exteriors only when cockroaches enter homes from the surrounding environment. Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage).

Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Common names (the names found on the list of active ingredients) of other effective pesticides include: propoxur (Baygon), cyfluthrin, permethrin, deltamethrin, and tetramethrin. A variety of formulations may be available, including sprays (liquid or wettable powders), aerosol sprays, baits or dust. No single chemical or formulation will control all cockroaches. Some German cockroach infestations are resistant to one or more insecticides. Apply insecticides only to cracks, crevices, or unexposed surfaces, and not beyond the point of runoff. Avoid spraying carpets, wallpapers, or other furnishings that might be stained.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures are what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8-inch mesh. Window screening must be kept in good repair. Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas.

Boric Acid
Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application.

Death’s Head Cockroach (*Blaberus craniifer)*

DEATH’S HEAD COCKROACH

The true death's head cockroach, Blaberus craniifer, is a cockroach which is very similar to the discoid cockroach and is a nice display animal for entomologists due to its striking appearance. Care for these animals is quite minimal and there is little odor associated with them. They do give off a mild odor if significantly frightened, but the effect is generally brief.

The name death's head comes from the markings on the top of the thorax. Adult B. craniifer have wings but do not fly, while juveniles do not have wings at all. This species also cannot climb smooth vertical surfaces, such as glass, which makes them easy to house in an open aquarium or similar.

Blaberus craniifer is the most misidentified and certainly one of the most difficult to find roaches. Most Roaches commonly sold as Death Head Roaches are either a Blaberus craniifer cross or another species, usually Discoid Roaches. Death Head Roaches are a live bearing species that grow to three inches or more. They are nervous roaches that are slow breeders. However, they are striking looking roaches. Adults have wings but do not fly, while juveniles do not have wings at all.

DEATH'S HEAD COCKROACH – SEE DEATH'S FACE IN DETAIL

DISCOID COCKROACH – JUVENILE

Discoid Cockroach (False Death's Head Cockroach)

The discoid cockroach is also commonly called the false death's head cockroach. This species of roach lives in tropical South America. They can grow up to 7.6 cm (3.0 in) long and although they have wings as adults, they do not fly. They also cannot climb smooth surfaces such as glass. These two characteristics make them easy to raise in an aquarium and they do not even require a lid. Most high protein food sources are sufficient to maintain them, such as dry dog food.

This species ranges in size from 35-45mm. Although branded as false death heads these roaches have no noticeable similarities to B. craniifer. Discoids have been one of the more common feeder roaches in the US pet industry for the past few years. These roaches usually reach adulthood in 3-5 months and then will live another 10-14 months. Both males and females have wings, but this is a non-climbing or flying species. This is not a native species, but because these cockroaches are used for feeding pets, it is more and more common to treat homes that have allowed these pests to escape and thrive.

The name death's head comes from the markings on the top of the thorax. Adult "B. craniifer" have wings but do not fly, while juveniles do not have wings at all. This species also cannot climb smooth vertical surfaces, such as glass, which makes them easy to house in an open aquarium or similar.

Pet Feeders
They are very easy to raise in captivity and therefore make good food for pets such as tarantulas, bearded dragon and other lizards. They breed somewhat faster than the true death's head cockroach. Most high protein food sources are sufficient to maintain these as feeders, such as dry dog food. Misting with water is required to maintain a high humidity level in captivity and to supply drinking water. A sponge in a shallow dish is also effective for drinking water. The markings on the back of the head give rise to the name death's head since it appears to be something like a vampire symbol to many people.

These animals breed readily in captivity. They reach breeding age in about 6 months if kept warm, with 85°F-90°F being recommended for more productive breeding. Females will carry their eggs inside a brooding pouch within their abdomen until they hatch. Discoid cockroaches also produce considerably less odor than crickets, another common feeder animal. They can survive on many substrates and to some extent they will clean their own cage, only requiring cleaning on a monthly basis or less.

Coconut fiber makes a good substrate as the nymphs readily burrow in it, and it holds humidity well. They can eat and should be given a variety of fresh fruit and vegetable scraps. Keep their food in a dish (or two) dry food and wet/fresh separate. On the opposite side of the tank keep and auto water dish or just a shallow water dish and replace when empty or dirty. Keep the roaches on mulch or peat and give them egg crates to spread out on. Also even though they cannot climb glass they can climb silicone and will climb the corners of the aquarium. If they get out they will desiccate if not given a water source, thus reducing the risk of infestation.

Life Cycle
Cockroaches have incomplete metamorphosis. Most species of cockroaches lay eggs in an ootheca (egg case) that is either deposited on or under suitable substrate, or carried attached to the genital region.

The egg stage lasts from a few weeks to a few months. The young are active from hatching and resemble the adults but are usually lighter in color and lack wings. The young cockroaches develop through a number of nymphal instars, which may range from 2 to 12 depending on the species and may take from a month or so up to 12 months to reach maturity. Some species may live for several years.

Field Cockroach (Pale Bordered Field Cockroach)
(*Pseudomops septentrionalis*)

FIELD COCKROACH

The Field cockroach is very similar in appearance to the German cockroach. It can be distinguished from the German cockroach by the blackish/brown area on the face from mouth parts to between the eyes. This species is slightly smaller and more greenish-brown in coloration than is the German cockroach.

The field cockroach, unlike the German cockroach, is not repelled by light and can often be seen during the day. It is most common in irrigated regions of southern Arizona and adjacent areas in southern California. It is associated with and feeds largely on decomposing vegetation; it also occurs under stones, clumps of earth, and similar objects. During the drier part of the year, it temporarily may come into the house in search of moisture.

Life Cycle
A life cycle can be completed in about 3 months. Female field cockroaches carry their egg capsules until they are ready to hatch. The number of eggs in a capsule usually is between 30-40, with a maximum of 48. The average number of nymphs hatching is 30. The average incubation period is 28.4 days. Capsules removed from the female do not usually hatch. Females at room temperature may produce an average of 4-5 capsules. The time for nymphs to mature to adults averaged 103 (54-215) days.

They progress through 6-7 nymphal instars in 60 days for males and 65 days for the females. Females may live for more than 200 days. Simple metamorphosis (egg, nymph, adult). Female cockroaches glue or drop 1/4 inch long bean-like egg capsules (oothecae) containing about 15 eggs on or around infested areas. Nymphs hatch from the egg case that resemble small grayish-brown adult cockroaches without fully developed wings. Nymphs molt 10 to 13 times in over a year (470 to 600 days, depending on temperature) before becoming adults.

Habitat, Food Source(s), Damage
This is generally an outdoor species, living in wood piles, decaying trees, palm trees and in sewer systems. Cockroaches have flattened bodies that allow them to enter homes through cracks around loose-fitting doors and windows, and where electric lines or pipes pass through walls. They are mainly active at night and hide in cracks and crevices during the day, preferring dark moist sites in attics and basements. Cockroaches eat almost anything including meats and grease, starchy foods, sweets, baked goods, leather, wallpaper paste, book bindings and sizing. Adults are capable of gliding flights.

Similar to Oriental Cockroach
Another similarly-sized, black-brown, common indoor species is the oriental cockroach, Blatta orientalis Linnaeus, but it differs because the wings on adults are rudimentary on the female and only cover 75% of the abdomen of the male. Other cockroach species come in a variety of sizes and shapes. Most are dark brown with or without color patterns on the body. Occasionally, a whitish cockroach is observed incorrectly thought to be an "albino" form. These are, in fact, roaches that have just molted and have not yet had time to darken their "new" exoskeleton.

Similar to Cuban Cockroach
There is, however, a pale green cockroach species, the Cuban cockroach, Panchlora nivea (Linnaeus) (Blattodea Blaberidae), which is occasionally encountered. Other common outdoor species include wood roaches, Parcoblatta spp. (Blatellidae) and the pale-bordered field cockroach, Pseudomops septentrionalis Hebard (Blattaria: Blattellidae).

Pest Status
Although not shown to be direct carriers of disease, they can contaminate food and kitchen utensils with excrement and salivary secretions and leave an unpleasant odor.

Odorous Secretions
Cockroaches in general produce odorous secretions from various points in their bodies. Such secretions can affect the flavors of various foods. When cockroach populations are high, these secretions may result in a characteristic odor in the general region of the infestation. Disease-producing organisms such as bacteria, protozoa, and viruses have been found in their bodies. Different forms of gastroenteritis (food poisoning, dysentery, diarrhea, etc.) appear to be the principal diseases transmitted by cockroaches. The insects carry these disease-causing organisms on their legs and bodies and deposit the organisms on food and utensils as they forage. Cockroach excrement and cast skins also contain a number of allergens, to which many people exhibit allergic responses such as skin rashes, watery eyes, congestion of nasal passages, asthma, and sneezing.

Field Cockroach Control
Controlling this roach is normally straightforward and fairly simple. Desiccant dusts and a good baiting system are usually sufficient to gain good control. The sprays and dusts used with success against household cockroach species are of very limited benefit against roaches.

Exclusion techniques that prevent roach entry should be considered. Doors and windows should be tightfitting and cracks, gaps and other possible entry points should be sealed. If a breeding site can be moved or modified (e.g., relocating a wood pile farther from the house) it might help. Also, store firewood outdoors until you are ready to burn it. The males are attracted to lights at night and limiting porch light use in late May through June when males are flying might be of some benefit. Outdoor insecticide barrier treatments around windows and doors and along the foundation. Direct application of insecticide to firewood does no good and is discouraged. Cockroaches inside need only be picked up discarded.

Field Cockroach Chemical Control
As breeding populations rarely become established indoors, house interiors should not be treated. Treat exteriors only when cockroaches enter homes from the surrounding environment.

Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair.

Boric Acid Control
Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid.

Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application. The use of residual sprays or aerosol foggers within a structure is of little value in controlling cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy. Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.

Technical Learning College

GENERAL PERIMETER SPRAY PATTERN

Florida Woods Cockroach (*Eurycotis floridana*) aka Skunk Roach

FLORIDA WOODS COCKROACH

The Florida woods cockroach (Eurycotis floridana), or palmetto bug is a large species of cockroach, which usually grows to a length of 1½ inch to 2 inches. It is black in color, and has a wide, glossy body, and appears at first glance to be wingless, however it does have very short wings just beneath its head, which are useless for flying. The cockroach, when disturbed, often emits a strong, disagreeable odor, somewhat reminiscent of amaretto. The Florida woods roach looks remarkably similar to the female Oriental cockroach, and the two could be mistaken for each other by the casual observer.

The roach is slower moving than other species. It prefers damp locations, lots of moisture, and does well in warm, damp climates. It is found in its native habitats, such as Florida, and the West Indies. The roach can wander indoors at times, especially into damp locations, such as bathrooms; however, it is found mostly outdoors and is not considered a major pest in the home. It is cold intolerant and requires a warm, sub-tropical or tropical climate. It can often be seen in sheltered outdoor locations, such as under leaf litter, in tree holes, and under lumber and boards, and other crevices. It is often seen in bushes and wooded areas. Often it can be seen on Palmetto trees, which gave it one of its early popular names, the Palmetto bug. Florida woods cockroaches have only one generation per year. Adults may survive for several years.

The Florida woods cockroach is so named Asian cockroach because it's primarily found if Florida in wooded areas. The nymphs have broad yellow bands on the top of their thorax. The average egg-to-adult development is approximately 100-150 days, and females will produce 20-24 eggs per egg capsule.

Adults have a long lifespan, and have a high reproductive capacity. This species can reproduce without fertilization by a male. They feed on decaying organic matter.

The Florida woods roach is also known as the Florida stink roach or ‘skunk roach’ as it known to emit an oily, vile-smelling liquid from a single gland on the underside of its abdomen when disturbed and to protect it from predators. It is apparently ejected only backwards, and when placed in a closed container it may cause its own death due to this secretion.

Life Cycle

Cockroaches have incomplete metamorphosis. Most species of cockroaches lay eggs in an ootheca (egg case) that is either deposited on or under suitable substrate, or carried attached to the genital region.

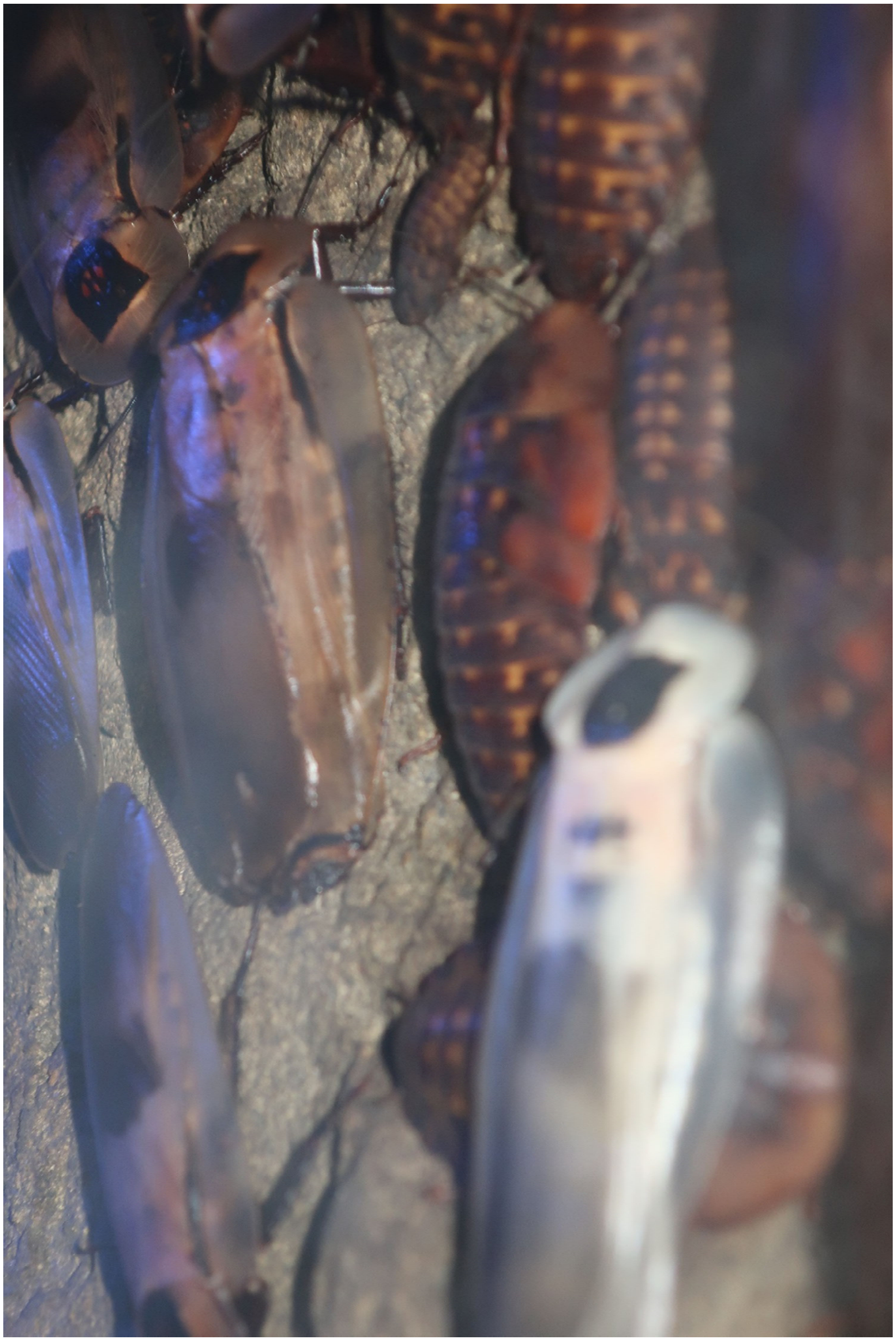
The egg stage lasts from a few weeks to a few months. The young are active from hatching and resemble the adults but are usually lighter in color and lack wings. The young cockroaches develop through a number of nymphal instars, which may range from 2 to 12 depending on the species and may take from a month or so up to 12 months to reach maturity. Some species may live for several years.

Giant Cave Cockroach (*Blaberus giganteus) - The Largest Roach*

GIANT CAVE COCKROACH
LOOKS LIKE DEATH HEAD'S COCKROACH

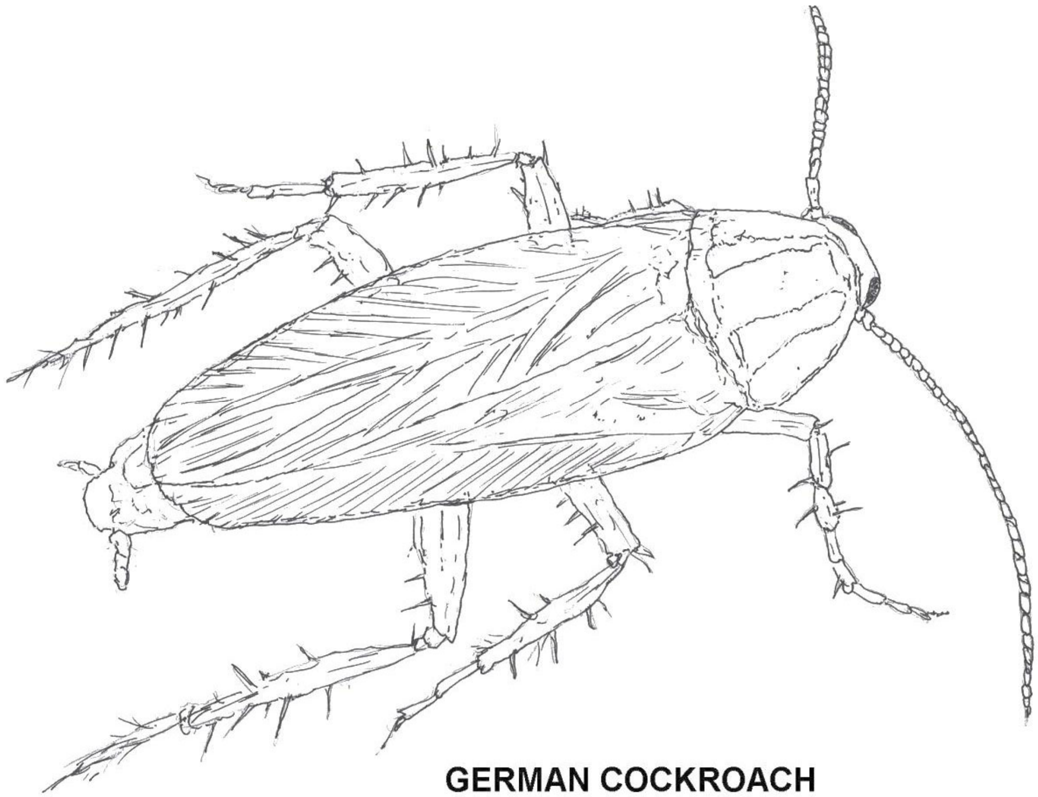
B. giganteus is considered one of the largest cockroaches in the world, with males reaching lengths of up to 7.5 cm (3.0 in) and females 10 cm (3.9 in), although others list 9 cm (3.5 in) as the maximum length. These cockroaches are lightly built with flattened bodies, allowing them to hide in cracks from predators. Their bodies are brown with black markings. The wingspan of these insects is usually around 15 cm (6 in). Both males and females bear paired appendages (cerci) on the last abdominal segment, but only the males have a pair of tiny hair-like appendages called styli.

Adults bear two phis species is endemic to Central America and northern South America, and can be found in the rainforests, in Mexico, Guatemala, Panama, Colombia, Venezuela, Brazil, Trinidad and Tobago, Guyana, Suriname, and French Guiana. Habitat preferences include areas of high moisture and little light, such as caves, tree hollows, and cracks in rocks. Pairs of wings folding back over the abdomen. The heavier females are less likely to fly. These incredible cockroaches are rare in the US. This is another roach species that people will keep as pets.



Giant Cave Cockroach (*Blaberus giganteus) - The Largest Roach*
Life size photo

German Cockroaches *(Blattella germanica)*



GERMAN COCKROACH

The German cockroach is the most common and the most difficult to control. Both adults and nymphs are light brown and have two longitudinal dark lines on their thorax (back). Adults are 1/2 to 3/4 inch long, and both males and females have wings as long as the body. Nymphs are similar in general appearance, but lack wings and may be as small as 1/8 inch.

The adult German cockroach is about 5/8 inch long, overall light brown in color with wings that cover the abdomen. The thoracic shield just behind the head (pronotum) is marked with two prominent black stripes. Immature stages (nymphs) are smaller, wingless and have a pale stripe (on at least the second and third thoracic segments in first stage nymphs) running lengthwise down the middle of the darker brown body.

The **field cockroach**, *Blattella vaga* Hebard, is similar to the German cockroach in appearance, but it occurs primarily outdoors where it feeds on decaying plant materials. Compared to the German cockroach, it is more active during daylight hours and will be found around lights. They also are known to fly when disturbed.

The **brownbanded cockroach**, *Supella longipalpa* (Fabricius) is about the same size as the German cockroach, but appear " ***banded***" because the wings are marked with a pale brown band at the base and another about a third of the distance from the base.

Life Cycle
Mated females produce an egg capsule that is attached to the end of the abdomen for up to a month before being dropped a day or so before eggs hatch. Each 5/16 inch long, brown egg capsule contains 30 to 40 eggs (oothecae) which hatch in 2 to 4 days after being deposited. Nymphs hatching from eggs are less than 1/8 inch long and wingless. They develop through 6 to 7 stages (instars) over 74 to 85 days (varying with temperature) before becoming adults. There may be four generations per year.

Habitat, Food Source(s), Damage
This is mainly an indoor species, although they will also migrate outdoors from structure to structure. Occasionally, new infestations begin by bringing in cartons and other materials from infested structures that harbor the roaches or their eggs. Kitchens, bathrooms and other locations that provide food, moisture, warmth and shelter are preferred habitats. German cockroaches are mainly active at night, when they search for food and water.

During the day, they remain concealed in cracks and crevices unless they are over-crowded, with all developmental stages occurring together. They also can occur in attics, wall voids, crawl spaces, foundation cracks, garbage areas and around the landscape. May spread food contaminants and allergens. Some people have allergic reactions to cockroaches or cockroach residues (*e.g.*, feces, body extracts).

Life Cycle and Biology of the German Cockroach
Cockroaches have three life stages: egg, nymph, and adult. Each capsule contains 30-48 eggs. The nymphs shed their skins 5 to 6 times before they grow into adults. The adults have wings, which distinguish them from nymphs. It takes from 40 to 125 days for an egg to mature into an adult. Each adult female can produce 4 to 8 egg capsules. The adult cockroach can live up to a year. Cockroaches eat many kinds of materials. They are especially fond of starches, sweets, beer, and meat products.

They also feed on leather, bakery products, flakes of dried skin, dead animals, and plant materials. Cockroaches hide in dark narrow cracks and crevices. They tend to gather in corners (in the back of cabinets or drawers, for example) and generally travel along edges such as baseboards. They are most active during the night.

Pest Status
One of the most common household cockroach pests in the U.S.; presence in homes is a nuisance and they may spread food contaminants. Some people have allergic reactions to cockroaches or cockroach residues (*e.g.*, feces, body extracts).

The German cockroach has approximately six generations per year and each generation is completed in 50 to 60 days. The adult German cockroaches have a life expectancy of six months. This roach cannot fly but may glide very short distances if disturbed.

German cockroaches can live in almost any room of a home or building. Because these roaches require water, they prefer a warm moist environment, such as around kitchen and bathroom sinks, appliances, furnaces, water heaters and furnace ducts.

Figure 1. German Cockroaches *Blattella germanica* (L.) with egg case

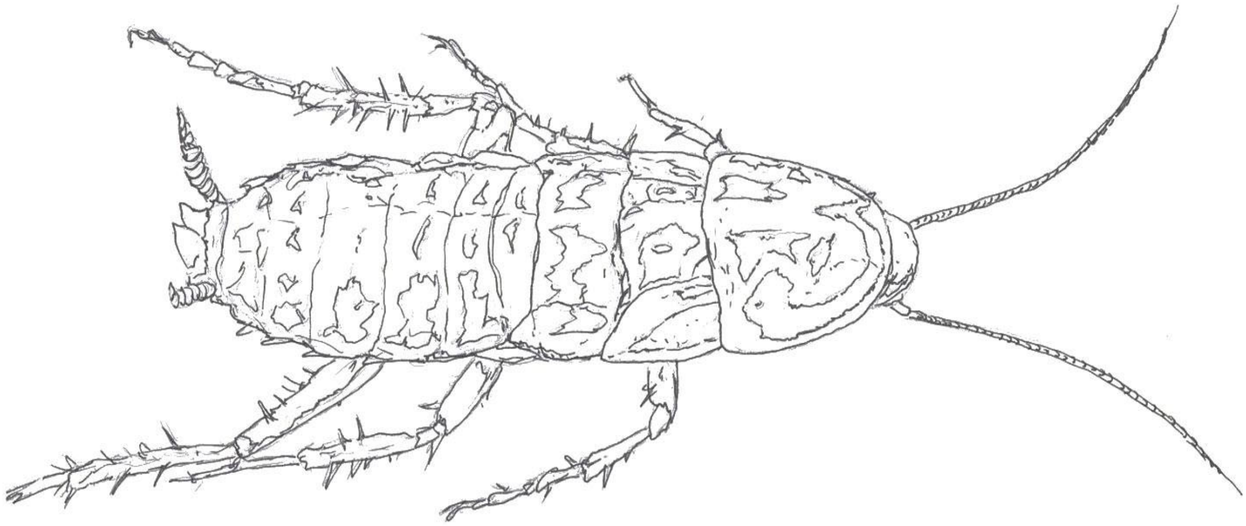
A roach does not need heads to breathe -- they absorb oxygen through their bodies and can survive for a month without food. A headless cockroach will live for about a week until it dies of thirst.

Cockroach Heat Eradication Chart	Lethal Temperature	Duration Time
German Adults	115° F	60 Minutes
German Adults	120° F	30 Minutes
German Adults	125° F	20 Minutes
German Adults	130° F	10 Minutes

The nearest relatives to cockroaches include mantids, grasshoppers, stick insects, and termites (Cornwell 1968).

Life size photo

Harlequin Cockroach (*Neostylopyga rhombifolia*)



HARLEQUIN COCKROACH

The Harlequin roach is certainly among the neatest looking of the pet roaches and is a very quick moving medium sized species. Nymphs start out life as a plain tan color but slowly molt to become very incredible looking adults. Harlequin roaches easily scale smooth surfaces and like most other glass climbers can be controlled by petroleum jelly. Also, this roach is an egg laying species. Even though the harlequin cockroach has spread to various parts of the world, it is not considered to be a pest. There are very few reports of harlequin cockroaches invading homes in the United States.

The harlequin cockroach grows to be almost 10.5″ long. The female produces an egg case, called an ootheca. The female carries the egg case for a few days before leaving it in a suitable area to hatch. In the immature, nymph stage, the roaches are tan-colored insects. As they grow the nymphs molt or shed their skin. Each time they molt, they develop more of the pattern of the adult roaches.

Both male and female harlequin cockroaches have very short front wings. Their back wings are absent altogether. Because of this, they do not fly. However, they can run very fast. Because of its colorful appearance, the harlequin cockroach is popular with people who keep cockroaches as pets. People who are thinking about raising these cockroaches are cautioned that, like many other roach species, the harlequin cockroaches are excellent climbers. Smooth vertical surfaces are not obstacles. They can easily climb out of glass containers where people keep them. Experienced cockroach keepers suggest applying a coating of petroleum jelly around the rim of the container to keep the roaches from climbing out and escaping.

An approach that integrates several strategies is required to deal with cockroaches, beginning with regular monitoring.

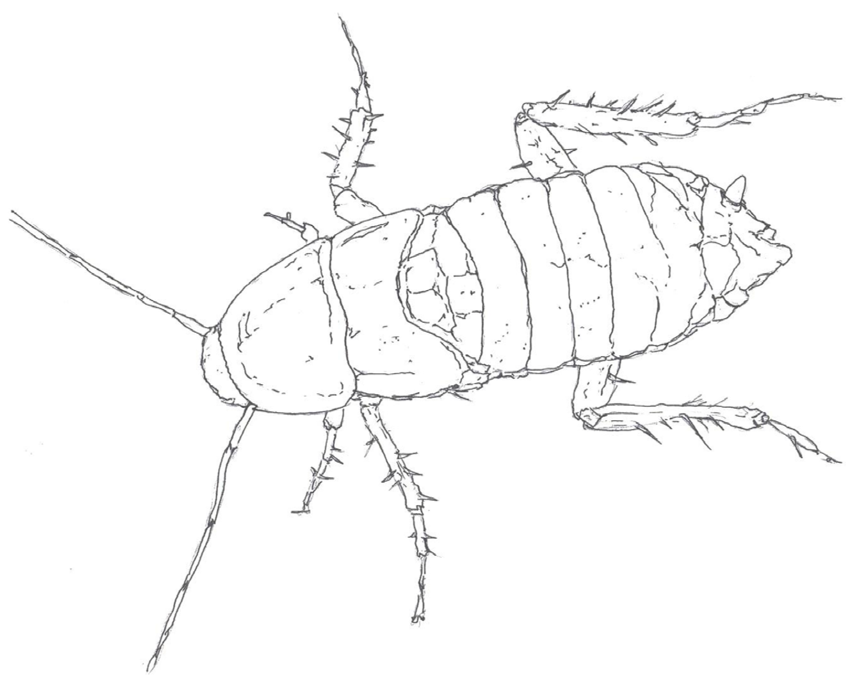
Only monitoring can give you the information needed to efficiently and effectively deal with the situation, i.e. which cockroach is present, how are they arriving (as invaders from outside, or in food supplied from a distributer), how many are there, and are they breeding - as indicated by the presence of both adults and nymphs?

Regular monitoring will let you know early on if you have cockroach invaders, and the problem can be dealt with before it becomes extensive.

Some cockroaches do not move extensive distances. German cockroach nymphs will only move a few feet from where their egg case hatched. Finding nymphs in a monitoring trap indicates that you are exactly where the cockroaches are infesting; this is the location that needs to be cleaned, uncluttered, and possibly treated with a bait.

What do Cockroaches Feed on?
Cockroaches feed on a wide variety of food (grease, crumbs, pet food, wax, gum, leftover food in empty food cans etc.). They also eat paper if it has glue on it, and some will feed on soap bars. Cockroaches can withstand long periods of starvation and can live for many days without water.

Do Cockroaches Transmit Disease?
Cockroaches are scavengers. While walking on spoiled food in garbage containers, they pick up various bacterial organisms on their legs that they can later deposit on uncovered food. Cockroaches themselves are not implicated in the transmission of any diseases. However, many disease-causing organisms can grow and multiply in their guts and can then be deposited on silverware, plates etc. during defecation. For example, cockroaches can pick up disease-causing bacteria like Salmonella on their legs and later deposit them on foods and cause food poisoning. People continuously exposed to dust containing cockroach feces and crushed body parts become sensitized and may show allergic reaction and asthma after repeated exposure to such dust.



TURKESTAN COCKROACH

Madagascan Giant Hissing Roaches (*Gromphadorhina portentosa*)

MADAGASCAN GIANT HISSING ROACH - PET

The cockroach family, to which Madagascan roaches belong, is among the most primitive of the winged insects, and yet is a highly designed creature. The nearest relatives to cockroaches include mantids, grasshoppers, stick insects, and termites (Cornwell 1968). The fossil record shows that roaches were very abundant during the Carboniferous period. There are at least 3,500 known species living today, in 450 genera, most of which originate in the tropics.

As a group, cockroaches exhibit a wide diversity of sizes, colors, and habits. Although they have an infamous reputation as household pests, in reality only about half a dozen species (less than one percent of all known forms) have negative associations with humans. Many species are diurnal, some are semiaquatic, and others live in the ground or are wood-boring. Some, such as the Madagascan roach, do not have wings. About a dozen or so species live commensally in the nests of ants, wasps, or termites. There are also roach species that inhabit caves with bats or live in the desert. The majority of cockroaches in tropical countries exist as scavengers outdoors, feeding on vegetation and organic matter in an apparently harmless fashion.

Did you know that these creatures are immune to Cobra venom?

The toxicity of the Thailand and Middle-Asian cobra venoms as well as of their isolated components (neurotoxins, cytotoxins, phospholipases and some others) for cockroach Gromphadorhina portentosa was studied. It was found that, as compared to mammals, cockroaches are more resistant to cobra venoms and their components.

Nothing as nice as a jeweled cockroach. This would be a nice gift for any pesticide sprayer's wife. We are thinking that humans have lost their minds that we must have cockroaches as jewelry or as pets. It was widely reported that Oprah Winfred once had cockroaches as pet because she was very poor as a youth. I guess, now she can afford diamond encrusted cockroaches as pets. I know some of you out there will eat a big cockroach for dinner tonight. You might call it a crustacean instead, but we know it is really a big fat juicy cockroach from the sea.

Only the Giant Cave Cockroach is larger in size. The problem with Cave Roaches is that they prefer dark locations while the Madagascan roaches can live with normal daylight. Both are considered pets in the US and are sold at pet stores. I have seen cages filled with both species and people treating these creatures like normal pets - like a dog or cat.

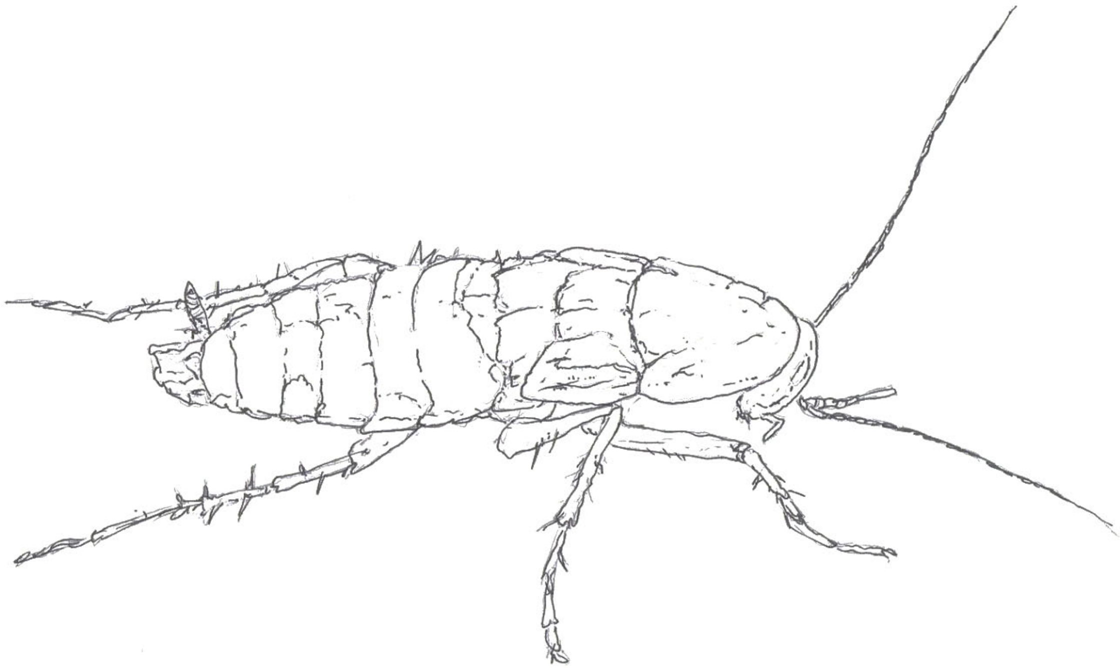
Oriental Cockroach (*Blatta orientalis*)

ORIENTAL COCKROACH

This dark reddish brown to black roach is commonly referred to as the "***water bug***." It is considered the most repulsive of all of the roaches and has a strong odor. The adult females are 1 1/4 inches long and almost wingless. The adult males are 1 inch long and have wings that are about half as long as their body.

Neither males nor females can fly or glide. The female carries an egg capsule for about 30 hours and then drops or attaches it to a protected surface near food. On average, a female produces eight egg capsules, each containing 16 eggs which hatch within 60 days. The reproductive cycle of this roach is completed in 6 to 9 months.

Oriental roaches prefer damp, cool, dark areas. They are generally found in sewer drains, crawl space areas, basements, cellars, or on the first floor of buildings. Infestations by this roach are most frequently found during spring (April and May) and fall (October). They may spend considerable time outdoors during warm weather.



ORIENTAL COCKROACH

Blatta orientalis is common outdoors, and lives in warm damp shady areas near the ground or any area containing natural debris. It will often seek refuge indoors when a drop in temperature occurs, but is still quite tolerable of cooler weather. The most common areas to find B. orientalis are basements, crawl spaces, areas between the soil and foundation, underneath sidewalks, in sewer pipes, in floor drains, and under sinks or any other damp cool area in the house. The roach travels through the structure on plumbing pipes.

Outside the house they sometimes aggregate near or under garbage cans. The species tends to be seasonal, with adults appearing in spring and summer. When large numbers of roaches occur, overcrowding can lead to the mass migration of roach species such as the German cockroach, Blattella germanica, the American cockroach, Periplaneta americana, and the oriental cockroach. The origin of the oriental cockroach, Blatta Orientalis Linnaeus, is uncertain, but it is thought to be from Africa or south Russia. It is a major household pest in parts of the northwest, mid-west, and southern United States. It is also sometimes referred to as the "black beetle" or a "water bug" because of its dark black appearance and tendency to harbor in damp locations.

Three Developmental Stages
The Oriental cockroach has three developmental stages: egg, nymph, and adult. Eggs are laid in capsules, which the female carries for about 30 hours and then drops onto a protected surface near a food supply. The female does not glue the egg capsule to the surface. An adult Oriental cockroach is about 1 to 1-1/4 inches long and dark brown, almost black. A male has fully developed wings which are shorter than the body. A female has very short, rudimentary wings (fig. 3). A nymph is similar in appearance to a female only it is smaller and wingless. A female deposits an average of eight egg cases during its lifetime; each capsule produces about 16 young. It takes 300 to 800 days, depending on conditions, for Oriental cockroaches to hatch from eggs and develop into adults.

Oriental Cockroach Damage
Oriental cockroaches feed on all kinds of filth, rubbish, and other decaying organic matter. They seem especially fond of garbage and the contents of discarded tin cans. If water is available, they can live for a month without food; without water they die within two weeks. The most important aspect of cockroach damage derives from their habit of feeding and harboring in damp and unsanitary places such as sewers, garbage disposals, kitchens, bathrooms, and indoor storage areas. Filth from these sources is spread by cockroaches to food supplies, food preparation surfaces, dishes, utensils, and other surfaces. Cockroaches contaminate far more food than they are able to eat.

Odorous Secretions
Cockroaches in general produce odorous secretions from various points in their bodies. Such secretions can affect the flavors of various foods. When cockroach populations are high, these secretions may result in a characteristic odor in the general region of the infestation. Disease-producing organisms such as bacteria, protozoa, and viruses have been found in their bodies. Different forms of gastroenteritis (food poisoning, dysentery, diarrhea, etc.) appear to be the principal diseases transmitted by Oriental cockroaches. The insects carry these disease-causing organisms on their legs and bodies and deposit the organisms on food and utensils as they forage. Cockroach excrement and cast skins also contain a number of allergens, to which many people exhibit allergic responses such as skin rashes, watery eyes, congestion of nasal passages, asthma, and sneezing.

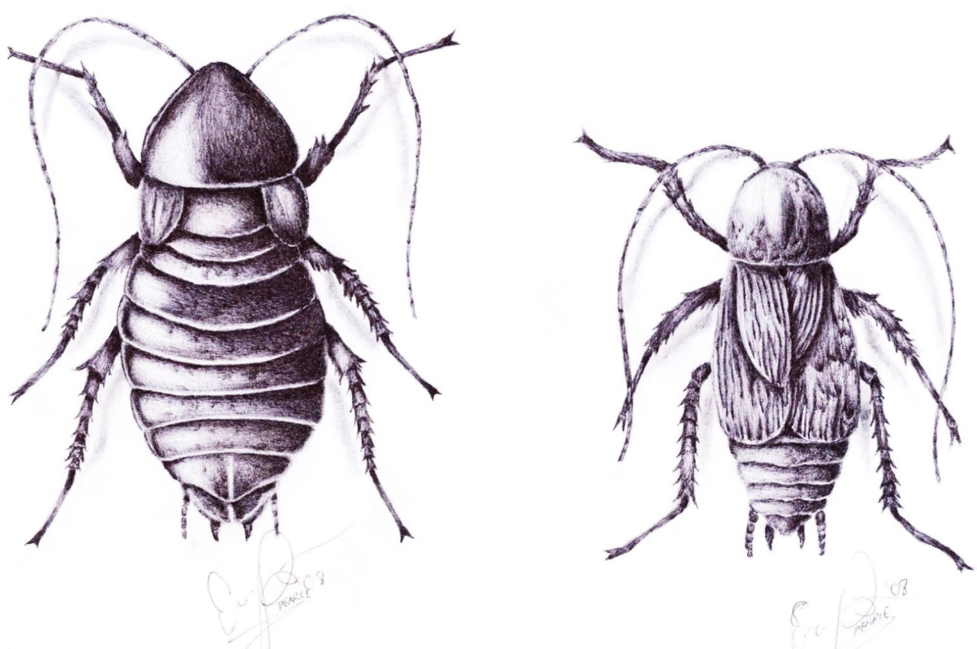
Management
Survey - To control Oriental cockroaches, it is important to do a thorough inspection. A cockroach survey (trapping) is sometimes necessary to determine the extent of an infestation, because even a thorough inspection will not reveal all cockroach harborages or areas where they forage most actively at night. Surveys are particularly useful in houses and buildings where there is a moderate to heavy level of infestation. Cockroach surveys involve placing sticky traps at strategic locations within the building. Whenever possible place survey traps either against a wall or in a corner of the floor. Most commercially available traps come complete with bait to encourage cockroaches to enter. One week of trapping at a sufficient number of trapping sites usually provides enough information for more complete and effective control.

Sanitation, Structural Modifications, and Repairs
Modifying the interior environment—removing food, moisture, and harborages for cockroaches—is the first step in treatment. Eliminating cockroach harborages involves caulking in closets and cabinets, caulking under the sink, etc., or making similar structural repairs in the kitchen, bathroom, and other areas of the house.

Move into Dwellings
Oriental cockroaches may move into dwellings from the outside. Recent research has been conducted on the movement of Oriental cockroaches under, around, and into homes from harborages in crawl spaces and cinder block foundations. The research has shown that these cockroaches frequently move into the home along plumbing (e.g., up through the floor from underneath the crawl space) and under door or window jams. The use of screening, caulking and similar items may be useful in tightening the exterior to deter entry by the cockroaches.

Chemical Control
Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of Oriental cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application.

The use of residual sprays or aerosol foggers within a structure is of little value in controlling Oriental cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy. Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.



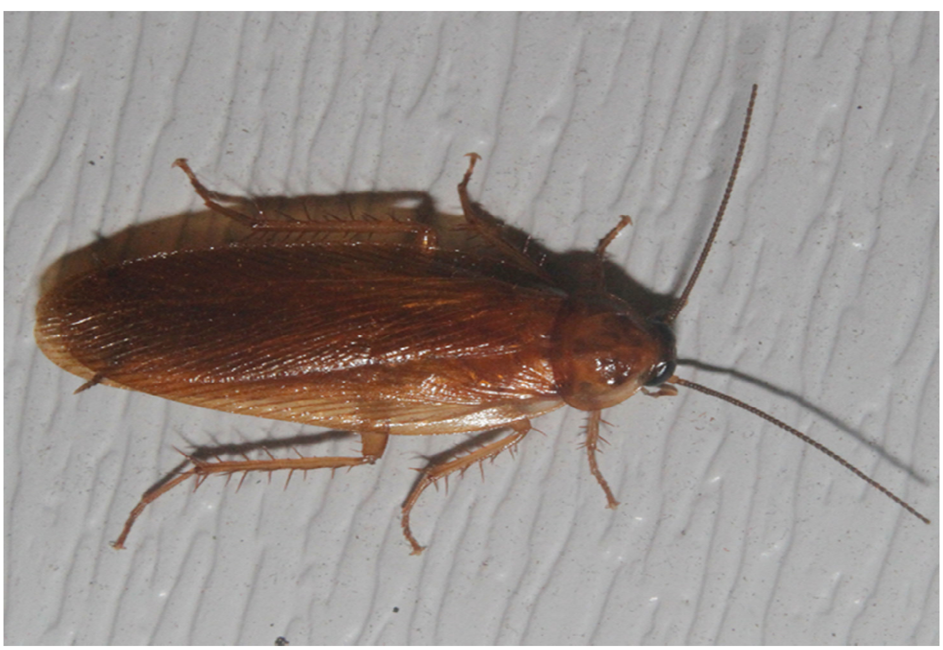
ORIENTAL COCKROACH

Palmetto Bug AKA American Cockroach

There is no difference between a cockroach and a palmetto bug. The cockroach is also known as the waterbug, Croton bug and palmetto bug. Originally from tropical Africa, cockroaches are thought to have been brought to North America aboard slave ships. Today, they are found thriving across the globe.

AMERICAN COCKROACH AKA PALMETTO BUG

Palmetto bugs are reddish-brown in color and are considered large insects, sometimes exceeding 1.5 inches in length. Some cockroach species have wings, although most are incapable of flight. Adult cockroaches have shiny bodies with yellow margins behind the head. Male and female cockroaches are typically approximately the same size and appear similar.



WOOD COCKROACH – LOOKS LIKE AMERICAN COCKROACH

Both have a pair of cerci at the tip of the abdomen, although only males have styli. Many would say that a flying cockroach is about as awful a thing the animal kingdom could produce, but to add to their mystique, the Palmetto Bug is also quite fast. In fact, in 1991 a research experiment was carried out at the University of California at Berkeley and a registered record speed of 3.4mph was one of the most astonishing results. Based on body size, this could be comparable to a human running 205 mph (330kph).

Chemical Methods for Palmetto Bug/American Cockroach Control
Dust Cracks & Crevices

- The dusts that work best against Palmetto Bugs are Delta Dust and CB Borid Boric Acid.
- Using a hand duster and following label instructions, apply dust liberally where roaches travel--underneath and behind baseboards, behind wall outlets, in wall voids, in cupboards and cabinets, and underneath appliances such as washers and dryers.

Apply a Liquid Residual to the Perimeter

- Demand CS, Suspend SC, or Demon WP provides excellent control when mixed in a 2 gallon sprayer and applied at a low-pressure setting.
- Spray indoors along baseboards, especially in corners; window and door frames, on the underside of furniture, behind bookshelves, and in other problem areas as listed on the product label. With Palmetto bugs, the other perimeter of the home or structure should also be treated.
- Residual sprays need to be reapplied every month to every 3 months, depending on the level of infestation.

Baits

- Use Niban FG in attics, basements, and crawlspaces where Palmetto Bugs enter, and for added protection, spread DeltaGard G Granules outdoors in pine straw and mulched areas surrounding the infested structure.

Contact Killers
Contact sprays will kill roaches immediately on contact, and can also be used to "flush out" roaches from suspected harborages. Contact Sprays for Palmetto Bugs/American cockroach include CB-80 Extra, Cy-Kick, D-Force HPX, 565 Plus XLO.

IGR
An IGR is a chemical used to disrupt and impede the life cycle of insects in the egg and larvae stage of development. The idea with an IGR is that if an insect cannot reach adulthood, it cannot reproduce. In short, IGR is a form of "birth control" for Palmetto Bugs and other pests, which helps to keep populations under control by preventing current and future infestations.

- The most common and effective IGR for roach control is Gentrol IGR, which comes in an aerosol, concentrated liquid, and point-source tablet.
- We recommend Gentrol IGR Concentrate to be added to your hand sprayer and sprayed right along with your baseboard chemical (Demand CS, Suspend SC, or Demon WP).
- For kitchen and bathroom areas, Gentrol Aerosol is the formulation of choice. Using the straw attachment, the IGR should be applied liberally to all visible cracks and crevices, including underneath, behind, and alongside appliances, behind

outlets, along pipe collars, inside wall voids, and on top of kitchen cabinets near the ceiling.
- Continue to apply IGR every 4 to 6 weeks for up to 6 months, or until all signs of infestation have been eliminated.

AMERICAN COCKROACH HEAD

WESTERN WOOD COCKROACH

SMOKY-BROWN COCKROACH

Sand Cockroach

As their name implies, sand cockroaches are found near deserts and sand hills. Sand cockroaches live in sand dunes for most of the year and burrow deep within the soil in winter. Sand cockroaches eat the roots of desert shrubs, which also serve as their main source of water. Small ridges left in the sand indicate their presence. Sand cockroaches are nocturnal and adult females remain inside their burrows for most of the day in order to avoid sunlight.

SAND COCKROACH

Female sand cockroaches resemble trilobites more than they do other cockroach species: they are black, wingless and oval-shaped. Male sand cockroaches are dusty-brown in color. The females are wingless. Although it is rare, sand cockroaches do sometimes enter human dwellings. This species does not cause harm to humans and will not breed inside your home. However, they can be difficult to eradicate.

BOLL'S SAND ROACH

An approach that integrates several strategies is required to deal with cockroaches, beginning with regular monitoring. Only monitoring can give you the information needed to efficiently and effectively deal with the situation, i.e. which cockroach is present, how are they arriving (as invaders from outside, or in food supplied from a distributer), how many are there, and are they breeding - as indicated by the presence of both adults and nymphs?

Regular monitoring will let you know early on if you have cockroach invaders, and the problem can be dealt with before it becomes extensive. Some cockroaches do not move extensive distances. German cockroach nymphs will only move a few feet from where their egg case hatched. Finding nymphs in a monitoring trap indicates that you are exactly where the cockroaches are infesting; this is the location that needs to be cleaned, uncluttered, and possibly treated with a bait.

Exterior Treatments

Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair. Changing white incandescent bulbs to yellow bulbs around entrance doors may help.

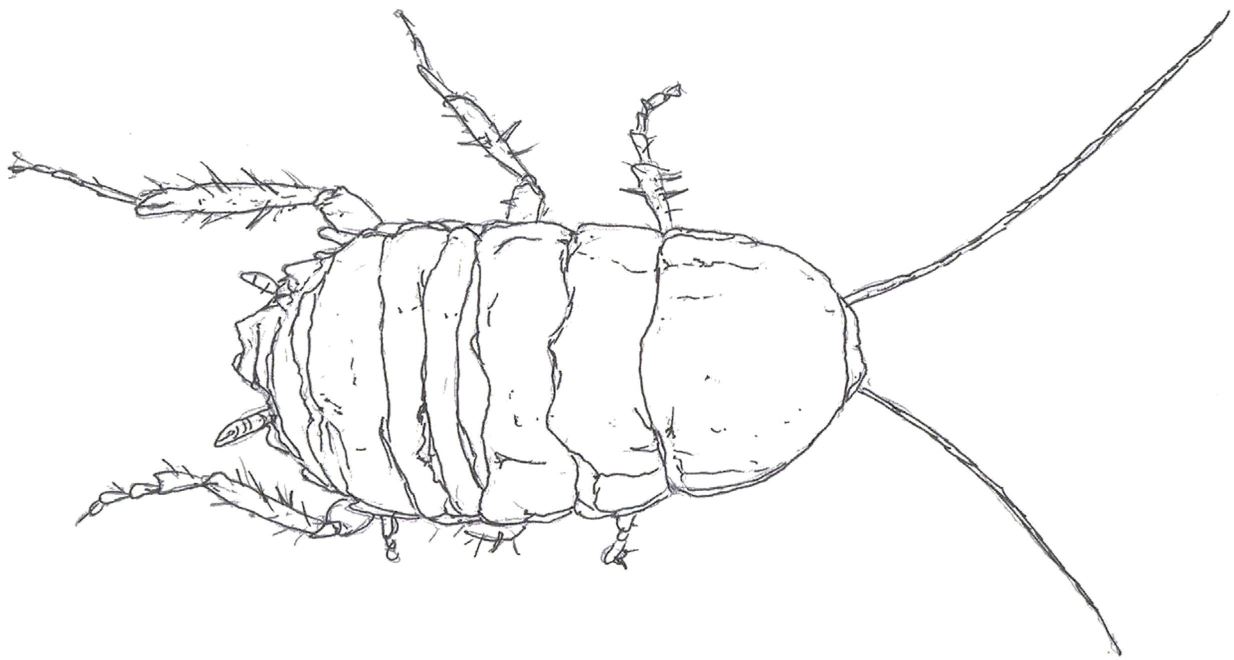
Chemical Control
Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them.

Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior.

Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application. The use of residual sprays or aerosol foggers within a structure is of little value in controlling cockroaches.

In fact, these applications may disperse the cockroaches making control difficult and lengthy. Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.

Skunk Roach AKA Florida Roach (*Eurycotis floridana*)



SKUNK COCKROACH

Adult size: 24-40mm (1 to 1 and 3/4 inches).
This adult is by far the largest of the egg laying species commonly kept and the egg cases are huge too. The background color of E. floridana is a strange maroon. In nearly all culture stocks, the medium-sized nymphs have yellowish margins along the sides of the thoracic segments but the adults are always completely maroon. There is also a rare culture stock from the Keys in which the adults retain the nymphal striping. 1st instar nymphs of this species are oddly able to (slowly) walk right over Vaseline so a sealed container is necessary.

Odorous Secretions
Cockroaches in general produce odorous secretions from various points in their bodies. Such secretions can affect the flavors of various foods. When cockroach populations are high, these secretions may result in a characteristic odor in the general region of the infestation.

Disease-producing organisms such as bacteria, protozoa, and viruses have been found in their bodies. Different forms of gastroenteritis (food poisoning, dysentery, diarrhea, etc.) appear to be the principal diseases transmitted by Oriental cockroaches. The insects carry these disease-causing organisms on their legs and bodies and deposit the organisms on food and utensils as they forage. Cockroach excrement and cast skins also contain a number of allergens, to which many people exhibit allergic responses such as skin rashes, watery eyes, congestion of nasal passages, asthma, and sneezing.

Management
Survey - To control Skunk cockroaches, it is important to do a thorough inspection. A cockroach survey (trapping) is sometimes necessary to determine the extent of an infestation, because even a thorough inspection will not reveal all cockroach harborages or areas where they forage most actively at night.

Surveys are particularly useful in houses and buildings where there is a moderate to heavy level of infestation. Cockroach surveys involve placing sticky traps at strategic locations within the building. Whenever possible place survey traps either against a wall or in a corner of the floor. Most commercially available traps come complete with bait to encourage cockroaches to enter. One week of trapping at a sufficient number of trapping sites usually provides enough information for more complete and effective control.

Sanitation, Structural Modifications, and Repairs
Modifying the interior environment—removing food, moisture, and harborages for cockroaches—is the first step in treatment. Eliminating cockroach harborages involves caulking in closets and cabinets, caulking under the sink, etc., or making similar structural repairs in the kitchen, bathroom, and other areas of the house.

Chemical Control
Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid.

Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of Skunk cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application.

The use of residual sprays or aerosol foggers within a structure is of little value in controlling Skunk cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy. Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.

Smokybrown Cockroach (*Periplaneta fuliginosa)*

SMOKYBROWN COCKROACHES

The adult is slightly more than 1-inch-long and is a uniform, very dark brown to black. The head shield is a solid dark color. Both males and females have wings longer than their bodies and are capable of flying or gliding. Nymphs are smaller than adults and have only partially developed wings.

Adult females usually carry their egg capsules for a day or two before attaching them to the outside surfaces of buildings and other protected sites near the ground. These cockroaches live primarily outdoors and prefer wood, leaf litter, trash piles and other humid sites with abundant organic matter. They also hide under rocks, ground cover and building materials. They may enter homes with infested firewood during seasonal migrations. The smokybrown cockroach is closely related to the American cockroach, but is a uniform shiny, dark-brown or mahogany color. It is about 1 1/4 to 1 3/8 inches long and the wings of both sexes cover the abdomen. The female has a broader abdomen than the male and lacks styli. Young nymphs have white markings on the thorax and abdomen, and on some antennal segments.

Older nymphs are uniformly dark brown. Smoky-brown cockroaches require high humidity for survival. They are found outside in wooded areas that provide shade and moisture. They can also be seen in protected areas around homes (tree holes and mulch) and in buildings and attics. Stacks of lumber and firewood, sewer-access openings and trash piles can contribute to infestations. Once in structures they are commonly found in attics or near fireplaces. These cockroaches can be attracted by a leaky roof.

The smokybrown cockroach, Periplaneta fuliginosa, is usually found in decorative plantings and planter boxes, woodpiles, garages, and water meter boxes; it may occasionally inhabit municipal sewers. They sometimes invade homes, taking refuge in areas such as the attic. Nymphs are dark brown and have white segments at the end of their antennae and across their backs. Smokybrown cockroaches prefer the upper parts of buildings; they also may live under shingles or siding and sometimes get into trees, shrubs, and other vegetation during summer months. Females carry the dark brown to black egg case, which measures about 3/8 inch long, for about 1 day before dropping it; eggs can quickly hatch in 24 days or take 70 days after being laid, depending on temperature. About 40 to 45 nymphs hatch from a single egg case.

Outside Living
Because the smokybrown cockroach is found outdoors, applications of insecticides to foundation plantings, wood piles, mulch, and other infested locations are recommended. Treatments placed to intercept cockroaches are both environmentally- and entomologically-sound. Residual barrier sprays have been shown to provide substantial reductions of smokybrown cockroach populations around houses. Power dusting of sewage lines, crawl spaces, false ceilings, wall voids, and trash chutes is an effective method of control. Space sprays, ULV treatment, or contact aerosols and sprays can be used in basements and utility rooms. Loose baits and other formulations better suited for damp locations can provide effective control in basements and similar areas.

Habitat
The Smokybrown cockroach has a great tendency to lose moisture through the cuticle and thus requires water every two to three days. These requirements are important to remember when implementing your roach extermination program.

This pest is most likely found in areas which are protected, moist, dark, relatively warm and free from the desiccating effects of air flow. In nature, tree holes and the canopies of palm trees offer the ideal environment in which this bug can thrive. The home equivalent of these conditions includes:

- Block Walls
- Flower Beds
- Any Mulched Areas
- Attics or Soffits with Moisture Problems
- Damp Basements
- Any Dark, Poorly Ventilated Area

Chemical Control Methods
The same treatment techniques that apply to carpenter ants can be used on acrobat ants. Finding and treating their colonies in wall voids and wood can usually control these ants.

Drilling small holes and dusting the infested areas with insecticide dusts can effectively treat infested walls and voids that harbor these ants. All colonies found outside should be treated directly with a liquid contact spray. Perimeter and foundation treatments of structures with a liquid insecticide will help prevent outdoor foraging ants from entering.

Spray applications to trees where Acrobat Ants are located are helpful. An approach that integrates several strategies is required to deal with cockroaches, beginning with regular monitoring.

Only monitoring can give you the information needed to efficiently and effectively deal with the situation, i.e. which cockroach is present, how are they arriving (as invaders from outside, or in food supplied from a distributer), how many are there, and are they breeding - as indicated by the presence of both adults and nymphs?

Regular monitoring will let you know early on if you have cockroach invaders, and the problem can be dealt with before it becomes extensive.

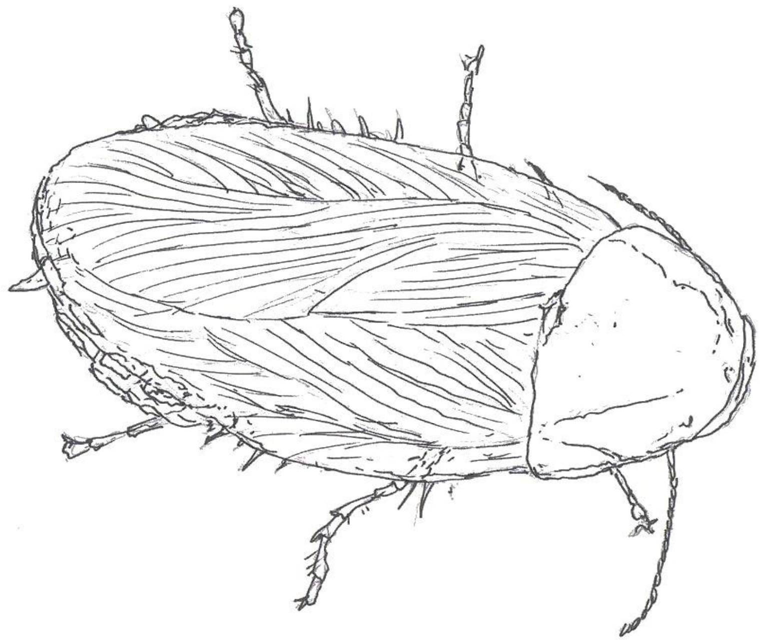
Some cockroaches do not move extensive distances. German cockroach nymphs will only move a few feet from where their egg case hatched. Finding nymphs in a monitoring trap indicates that you are exactly where the cockroaches are infesting; this is the location that needs to be cleaned, uncluttered, and possibly treated with a bait.

Control Smokybrown Cockroaches

1. Eliminate or alter any conditions which encourage the presence and/or reproduction of the roaches. These pests thrive in dark, humid areas which have little or no air flow.
2. Spray exterior of structure with Suspend SC, Demon WP or Cynoff WP. These odorless insecticides will give a quick knockdown of bugs while lasting for several weeks, usually yielding about a 90 day residual. Spray any crack, crevice or entry point on the outside of the structure. This includes treating around all windows, doors, vents and in weep holes of brick veneer. Also spray tree trunks, from ground to crotch of tree, but no higher than six feet. All mulched areas should be sprayed with insecticide. These exterior surfaces should be treated 3 to 4 times each year.
3. If necessary, spray indoors in the following areas: basements, garages, carports, attics, closets, laundry rooms. Also treat beneath and behind large appliances (refrigerators, stoves, etc.) or other areas where these roaches prefer to hide. (Spraying all of your baseboards with any bug spray is not necessary!) Indoor areas should be treated 2 to 3 times per year.
4. Hollow blocks or other areas such as behind brick walls and along plumbing lines should be treated with Delta Dust. Although many dusts will kill roaches, Delta Dust is water-proof and will not be destroyed by the moist habitat of the Smokybrown as would other dusts. For deeper penetration and better distribution of insecticide dust, use a Crusader Duster. Delta Dust should be used once each year or as needed.

PENNSYLVANIA WOODS COCKROACH

Surinam Cockroach (*Pycnoscelus surinamensis*)



SURINAM COCKROACH

The Surinam cockroach is a species of cockroach. It is approximately 3/4" in length, with uniformly dark brown wings, and a shiny dark brown or black head and pronotum (the shield behind its head).

The Surinam cockroach is reported around the world in the humid tropics and in the U.S. from Texas, Louisiana and Florida. It is a burrowing insect which is capable of destroying various plants and is often brought into homes, shopping malls, restaurants in potted plants. Although this cockroach is not in the strict sense a household pest, it is nevertheless a source of much annoyance in related structures such as greenhouses. This species lives primarily outdoors and is considered a nuisance pest, as it does not breed inside homes. It can appear in northern states, usually in shopping malls and zoos, where it is found in atriums and potted plants carried from nurseries in Florida and other southern states. In the South, the Surinam cockroach can build large populations around structures in landscape beds where thick mulch layers, heavy ground cover and landscape timbers are present. This species does not fly. The females reproduce parthenogentically without mating with a male. Surinam cockroaches are 3/4" to 1" long, are brown in color, and have a very obvious dark brown to black shield, (the area behind its head), which is called the pronotum.

Cockroaches are scavengers. While walking on spoiled food in garbage containers, they pick up various bacterial organisms on their legs that they can later deposit on uncovered food. Cockroaches themselves are not implicated in the transmission of any diseases.

However, many disease-causing organisms can grow and multiply in their guts and can then be deposited on silverware, plates etc. during defecation. For example, cockroaches can pick up disease-causing bacteria like Salmonella on their legs and later deposit them on foods and cause food poisoning. People continuously exposed to dust containing cockroach feces and crushed body parts become sensitized and may show allergic reaction and asthma after repeated exposure to such dust.

Control

To control this insect it is critical to remove harborage areas, such as excessive leaf litter, excessive mulch, unneeded landscape timbers, stones, or other objects close to the foundation of your building. Residual materials should be applied to foundations, plantings, woodpiles, potted plants, mulch and any infested areas. Barrier treatments can substantially reduce Surinam cockroach populations around your home. An approach that integrates several strategies is required to deal with cockroaches, beginning with regular monitoring. Only monitoring can give you the information needed to efficiently and effectively deal with the situation, i.e. which cockroach is present, how are they arriving (as invaders from outside, or in food supplied from a distributer), how many are there, and are they breeding - as indicated by the presence of both adults and nymphs? Regular monitoring will let you know early on if you have cockroach invaders, and the problem can be dealt with before it becomes extensive. Some cockroaches do not move extensive distances. German cockroach nymphs will only move a few feet from where their egg case hatched. Finding nymphs in a monitoring trap indicates that you are exactly where the cockroaches are infesting; this is the location that needs to be cleaned, uncluttered, and possibly treated with a bait.

Exterior Treatments

Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair. Changing white incandescent bulbs to yellow bulbs around entrance doors may help.

Common names (the names found on the list of active ingredients) of other effective pesticides include: propoxur (Baygon), cyfluthrin, permethrin, deltamethrin, and tetramethrin. A variety of formulations may be available, including sprays (liquid or wettable powders), aerosol sprays, baits or dust. No single chemical or formulation will control all cockroaches. Some German cockroach infestations are resistant to one or more insecticides. Apply insecticides only to cracks, crevices, or unexposed surfaces, and not beyond the point of runoff. Avoid spraying carpets, wallpapers, or other furnishings that might be stained.

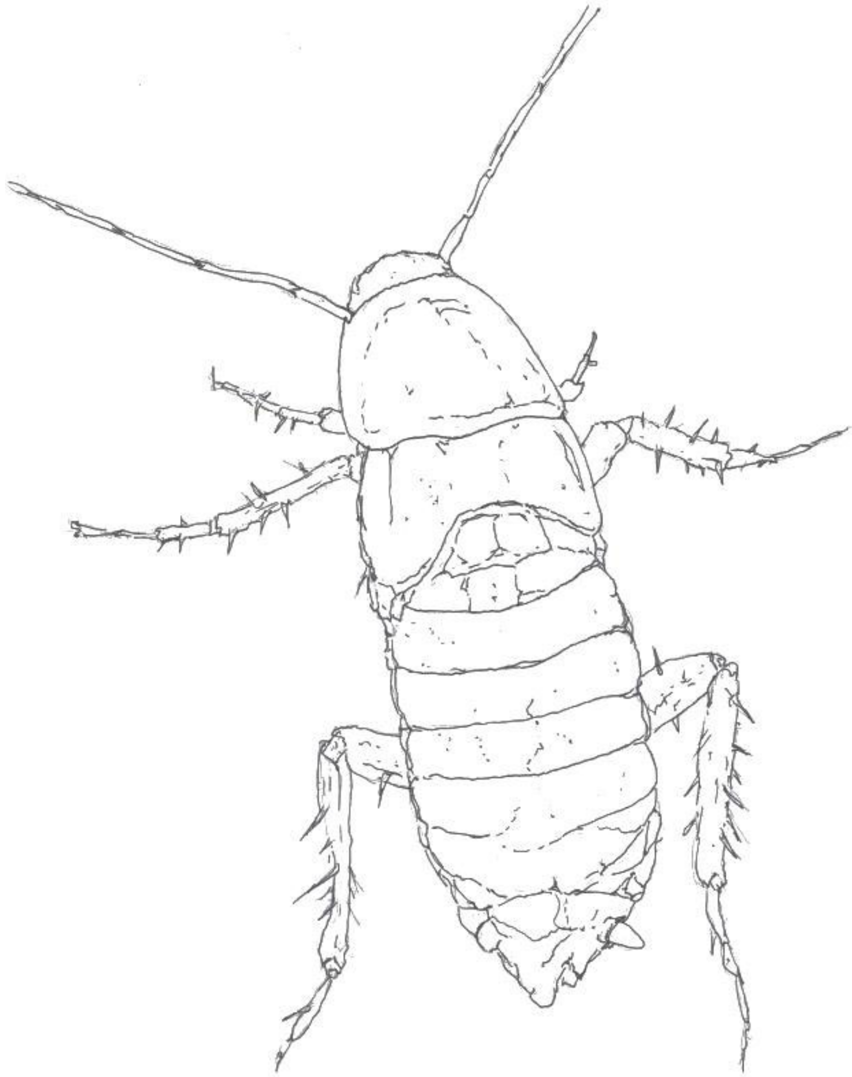
Chemical Control
Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food.

Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application. The use of residual sprays or aerosol foggers within a structure is of little value in controlling cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy.

Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.



TURKESTAN COCKROACH

Turkestan Cockroach *(Blatta lateralis)*

The Turkestan cockroach is a new cockroach to this country, and it is spreading. It was first seen in 1978 at a military base in Lathrop, California. Apparently it was a stow-away in household goods brought back from the Middle East. It has now also been reported in Arizona and Texas, and could eventually spread throughout much of the Southern United States.

TURKESTAN ROACH -FEMALE

A recent report shows that the Turkestan roach is now infesting schools in Los Angeles. Sometimes they are so numerous that custodians report it is difficult to walk the grounds on hot summer nights without stepping on them. These roaches live primarily outdoors and in sewers, but come indoors when it is dry, searching for moisture. Male and female Turkestan roaches look very different from each other. The males are easily mistaken for American cockroaches, and the females look very similar to Oriental cockroaches.

The male has long, yellowish-tan wings, they are usually found inside as they are attracted to lights and enter via poorly sealed doorways. The adults of this species grow to about 1" in length, with the female being a bit longer. The males are brownish yellow in color and the females are dark brown to black in color. The wings of the male extend beyond the abdomen whereas the female wings are very short triangular pads separated by less than a wings width. The nymphs (young) are bi-colored with the thorax (front) being light brown and the abdomen being dark brown. The ootheca or egg capsules are 3/8 to 1 "long, dark brown and contain about 18 eggs.

The female has short, rounded wings with creamy stripes along the edges and a pear-shaped body. This roach is typically found outdoors, but when it reaches peak populations in June, can be found indoors. This cockroach is not known to transmit disease, and is considered a beneficial decomposer in gardens and yards. Turkestan Cockroach prefers semi-arid to arid desert areas, in water meter boxes, cracks between blocks of poured concrete, compost piles, leaf litter, potted plants, and sewer systems.

Biology
Not a lot is known about this species other than nyumphal development takes around 118-137 days, and adults live from 30 to 300 days.

Control
Controlling this roach is normally straightforward and fairly simple. Desiccant dusts and a good baiting system are usually sufficient to gain good control. The sprays and dusts used with success against household cockroach species are of very limited benefit against roaches. Exclusion techniques that prevent roach entry should be considered. Doors and windows should be tightfitting and cracks, gaps and other possible entry points should be sealed. If a breeding site can be moved or modified (e.g., relocating a wood pile farther from the house) it might help.

Also, store firewood outdoors until you are ready to burn it. The males are attracted to lights at night and limiting porch light use in late May through June when males are flying might be of some benefit. Outdoor insecticide barrier treatments around windows and doors and along the foundation. Direct application of insecticide to firewood does no good and is discouraged. Wood cockroaches inside need only be picked up discarded.

Chemical Control
As breeding populations rarely become established indoors, house interiors should not be treated. Treat exteriors only when cockroaches enter homes from the surrounding environment.

Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair.

Exterior Treatments
Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

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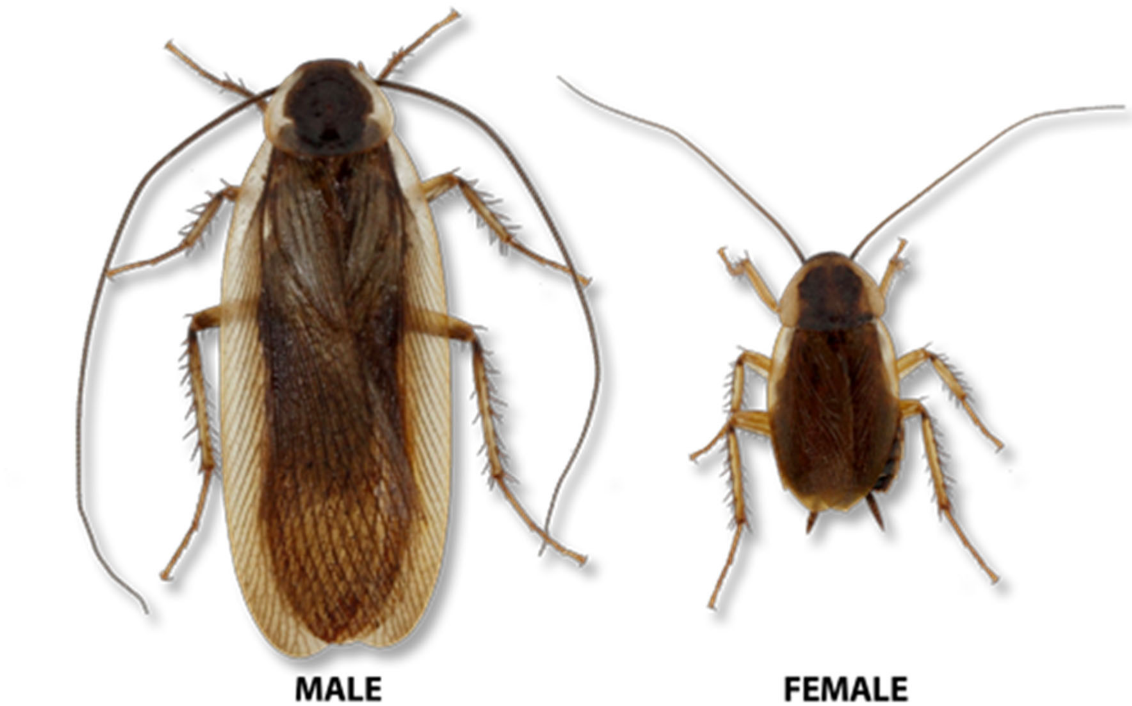
Window screening must be kept in good repair. Changing white incandescent bulbs to yellow bulbs around entrance doors may help.

Chemical Control

Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food.

Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application. The use of residual sprays or aerosol foggers within a structure is of little value in controlling cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy. Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.

Wood Cockroaches
AKA Pennsylvania Wood Cockroach (*Parcoblatta pennsylvanica*)



PENNSYLVANIA WOOD COCKROACHES

Wood roaches do not thrive and reproduce in homes because they require the consistently moist environment of their natural habitats such as under wood piles or loose bark and in decaying logs. Indoors, their presence is strictly a temporary annoyance. They do not harm the house structure, furnishings or occupants.

Wood roaches can usually be identified by the presence of white stripes on the edges of the thorax and front portion of the wings. This characteristic is more readily apparent in the slender, straw brown-colored males than in the dark brown females and nymphs. The wings of the males extend slightly beyond the tip of the abdomen. The females' wings cover only half of the abdomen, and nymphs are wingless.

Wood cockroaches are a group of minor cockroach pests. They are native to North America. Males are usually plain brown and 1 inch or less in length. Females are shorter and broader than males. Generally, females range in color from light to dark brown, with wings only half the length of the body or shorter. Males are good fliers and are often found around lights at night. Sometimes males fly into buildings. Outdoors, wood cockroaches are found in areas such as wood piles, mulch, and leaf litter. Indoors, wood cockroaches cannot survive very well and are seldom a problem. This group of roaches causes occasional problems in homes and public places.

They are seen in late May or June, especially after rains. This roach is often confused with both adult American and oriental roaches. However, the wood roach is chestnut brown and has a dull white band around the edges of the head and back.

Adults are 1 to 1 1/4 inches long. Females have wings covering only about half the body and do not fly. Males have wings longer than the body and are excellent fliers. Females produce about 30 egg capsules, each containing about 32 to 36 eggs. This roach completes one generation per year.

Wood cockroaches are usually found in wood piles, hollow trees or under loose bark. Buildings in wooded areas are prone to have problems with wood roaches during rainy periods. Although this roach prefers to live outside, adult males are attracted to light and may enter buildings. They are sometimes brought in along with firewood, but do not usually survive or multiply inside buildings.

Nymphs and Adults
Nymphs and adults are usually found outdoors beneath loose bark in woodpiles, stumps, and hollow trees. Brought indoors on infested firewood, they wander about the house without congregating in any particular room. They can be especially troublesome during the mating season, which is during May and June. Male wood cockroaches frequently travel in large numbers and fly considerable distances. They are attracted to lights at night and may gain entry indoors. Large numbers may also be found in rain gutters of homes.

Wood cockroaches feed primarily on decaying organic matter. Both female and male wood cockroaches have been found under shingles and on the inside of garages. They rarely breed indoors. However, with the growing use of firewood, the popularity of cedar shake shingles, and the continual building of homes in wooded areas, problems with wood cockroaches will probably escalate.

Structural (and Environmental) Modifications and Repairs
Wood cockroaches are most often carried into homes under the bark of firewood. It is best to not store firewood inside the house. Move woodpiles away from the house to further reduce the likelihood of cockroaches wandering in.

Houses located within woods will sometimes have wood cockroaches crawl under siding; especially homes with cedar shake shingles. To cockroaches, the house may represent a fallen tree and a new location for nesting. A wide lawn will inhibit cockroaches crawling from the surrounding woods to the house. The use of window screening and caulking to prevent entry is a good structural tactic.

Control
The sprays and dusts used with success against household cockroach species are of very limited benefit against wood roaches. Exclusion techniques that prevent wood roach entry should be considered. Doors and windows should be tightfitting and cracks, gaps and other possible entry points should be sealed. If a breeding site can be moved or modified (e.g., relocating a wood pile farther from the house) it might help. Also, store firewood outdoors until you are ready to burn it.

The males are attracted to lights at night and limiting porch light use in late May through June when males are flying might be of some benefit.

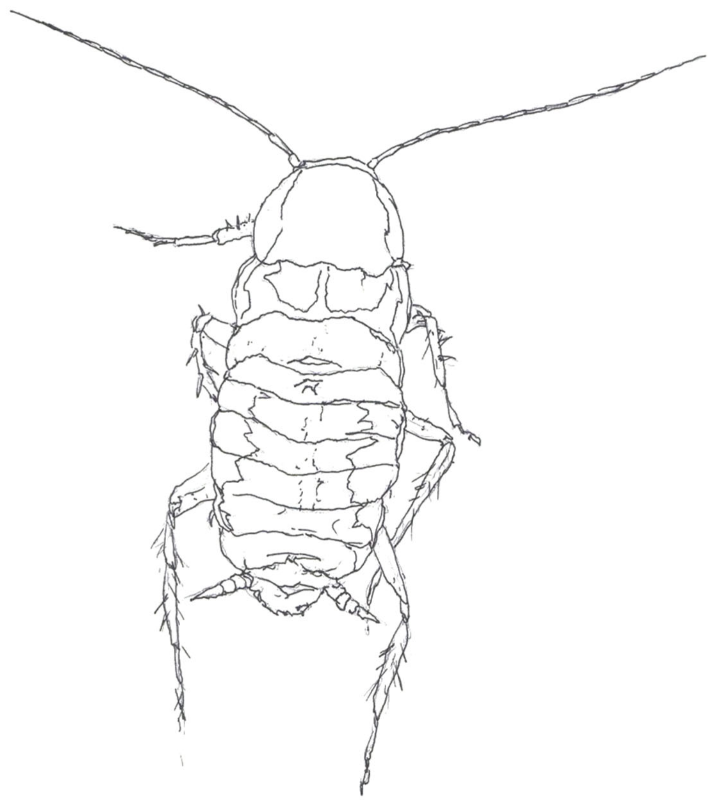
Outdoor insecticide barrier treatments around windows and doors and along the foundation or firewood pile are a last resort that may reduce the number of wood roaches that get indoors. Direct application of insecticide to firewood does no good and is discouraged. Wood cockroaches inside need only be picked up discarded.

Chemical Control

As breeding populations rarely become established indoors, house interiors should not be treated. Treat exteriors only when wood cockroaches enter homes from the surrounding environment. Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Treat exteriors only when wood cockroaches enter homes from the surrounding environment.

Exterior Treatments

Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.



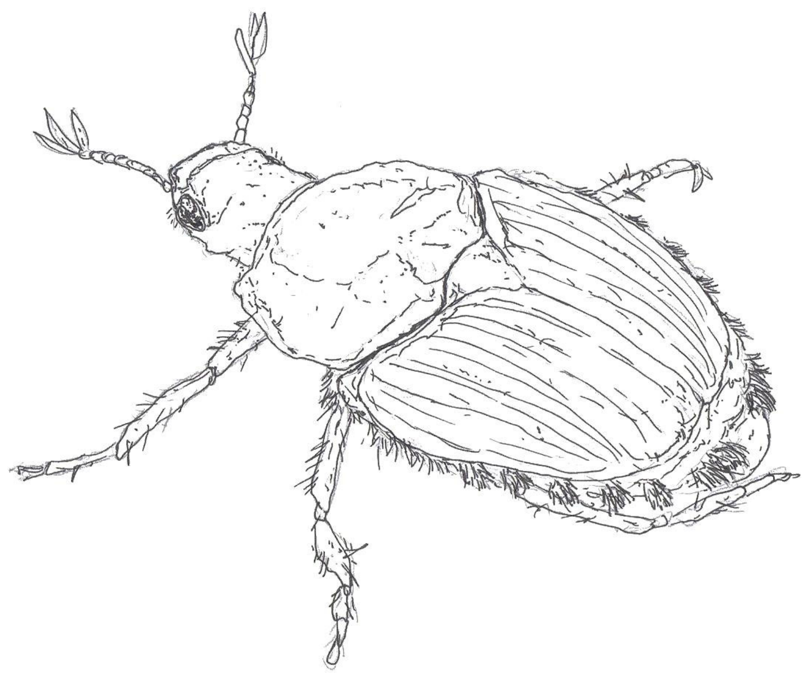
WOOD COCKROACH

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair. Changing white incandescent bulbs to yellow bulbs around entrance doors may help.

Chemical Control
Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid.

Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application. The use of residual sprays or aerosol foggers within a structure is of little value in controlling cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy. Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.

Common names (the names found on the list of active ingredients) of other effective pesticides include: propoxur (Baygon), cyfluthrin, permethrin, deltamethrin, and tetramethrin. A variety of formulations may be available, including sprays (liquid or wettable powders), aerosol sprays, baits or dust. No single chemical or formulation will control all cockroaches. Some German cockroach infestations are resistant to one or more insecticides. Apply insecticides only to cracks, crevices, or unexposed surfaces, and not beyond the point of runoff. Avoid spraying carpets, wallpapers, or other furnishings that might be stained.



JAPANESE BEETLE

Common Cockroach Identification Summaries

In general, peridomestic cockroaches are much larger and heavier than German cockroaches. Adults range in size from 1.5-1.75" (3-4 cm) in length and are reddish brown to black in color. Some of these large cockroaches can live up to 2 years in the adult stage. Adult females can produce an egg case about every 1-2 weeks. A typical female will produce about 20-80 oothecae during her lifetime each containing 15-20 nymphs. Peridomestic females release the egg case from their body soon after it has developed. They then "glue" the egg case to a surface, usually in a hidden, moist area.

In contrast, German cockroach females continue to carry the egg case throughout embryonic development. Peridomestic cockroaches normally breed outdoors in sewers, palm trees, tree holes, fire wood, water meters, well pumps, mulch, and flower beds. These cockroaches usually enter homes only occasionally when foraging for food, water or warmth. In some situations, however, they will establish breeding populations in attics, crawl spaces, wall voids and other indoor areas. Many cockroaches do not live in close association with humans. Others are found in only a few locations. These are considered minor pests.

American Cockroach
The American cockroach, Periplaneta americana, prefers warm and humid environments, usually with temperatures in excess of 82°F. Under the right conditions, they readily live outdoors and are common pests in zoos and animal-rearing facilities. They are also common in sewers, steam tunnels, and masonry storm drains. Occasionally they forage from sewers and other areas into the ground floor of buildings. Adult females carry the egg cases around for about 6 days and then cement them to a protected surface where they incubate for about 2 months or longer. The egg cases, which are about 3/8 inch long, are brown when laid but turn black in 1 to 2 days. Each egg capsule contains about 12 young; a female and her offspring can produce over 800 cockroaches in one year.

Biology
The length of the egg stage varies from 29 to 58 days. At room temperature, nymphs hatch out in 50 to 55 days. Young nymphs are grayish brown and after the first few molts become reddish brown. The nymphal stage varies in length from 160 to 971 days. The number of offspring per year averages 800. Under ideal conditions an adult female can live up to 15 months, males for a somewhat shorter period.

Sex
Adult American cockroaches have wings and will occasionally fly. However, they are awkward fliers and prefer to run when disturbed. Male and female American cockroaches are about the same size and look very similar. Both have a pair of cerci, finger-like appendages, at the tips of their abdomens. The cerci are used to detect air movement in the cockroach's surroundings.

Male cockroaches have an additional set of appendages called styli on their abdomens. The styli are located between the cerci but are smaller and more delicate. The presence of styli is the easiest way to distinguish male from female cockroaches. Immature American cockroaches resemble adults, except they are smaller and wingless.

Life Stages
Nymphs (immature stages) resemble the adults, but they are smaller and lack wings. Nymphal early instars (the stage between molts) are grayish brown with a paler lower surface. Older nymphs are uniformly reddish brown. Wing pads are evident in third or fourth instar nymphs. Egg cases (oothecae) are mahogany brown to blackish brown and about 3/8 inch long. The eggs in each egg case are arranged in two parallel rows, usually with 14 to 16 eggs total.

Brownbanded Cockroach
The brownbanded cockroach, Supella longipalpa, is not as common as the German cockroach in California and accounts for only about 1% of all indoor infestations. This species seeks out areas that are very warm most of the time, preferring temperatures of about 80°F, about 5° to 10°F warmer than what German cockroaches prefer. Favorite locations include near the warm electrical components of appliances such as radios, televisions, and refrigerators.

Brownbanded cockroaches prefer starchy food (e.g., glue on stamps and envelopes), are often found in offices and other places where paper is stored, and are more common in apartments or homes that are not air conditioned. They also infest animal-rearing facilities, kitchens, and hospitals. Adult males sometimes fly when disturbed, but females do not fly. Females glue light brown egg cases, which are about 1/4 inch long, to ceilings, beneath furniture, or in closets or other dark places where eggs incubate for several weeks before hatching. Each female and her offspring are capable of producing over 600 cockroaches in one year.

Field Cockroach
The field cockroach, Blattella vaga, prefers outdoor locations and is usually found in leaf litter and plant debris. Field roaches invade indoor areas when it is hot or dry outdoors and are often mistaken for German cockroaches. Field roaches are more olive in color than German roaches and they have a black stripe between the eyes. Adult females carry the egg cases until they are ready to hatch. Each egg capsule usually contains between 30 and 40 young. Development from a newly emerged nymph to adult can be completed in about 3 months.

German Cockroach
The German cockroach, Blattella germanica, is the most common indoor species, especially in multiple-family dwellings. They prefer food preparation areas, kitchens, and bathrooms because they favor warm (70° to 75°F), humid areas that are close to food and water. Severe infestations may spread to other parts of buildings. This species reproduces the fastest of the common pest cockroaches: a single female and her offspring can produce over 30,000 individuals in a year, but many succumb to cannibalism and other population pressures. Egg laying occurs more frequently during warm weather.

The female carries around a light tan egg case (about 1/4 inch long) until 1 to 2 days before it hatches, when she drops it. Sometimes the egg case hatches while it is still being carried by the female. Each egg case contains about 30 young, and a female may produce a new egg case every few weeks.

Oriental Cockroach

The oriental cockroach, Blatta orientalis, is sometimes referred to as a water bug or black beetle. It lives in dark, damp places like indoor and outdoor drains, water control boxes, woodpiles, basements, garages, trash cans, and damp areas under houses. It is most likely to occur in single-family dwellings that are surrounded by vegetation. It is also common in ivy, ground cover, and outside locations where people feed pets. Oriental roaches prefer cooler temperatures than the other species do, and populations of this species often build to large numbers in masonry enclosures such as water meter boxes. At night, oriental cockroaches may migrate into buildings in search of food. They usually remain on the ground floor of buildings and move more slowly than the other species.

Oriental cockroaches do not fly and are unable to climb smooth vertical surfaces; consequently, they are commonly found trapped in porcelain sinks or tubs. Females deposit dark red-brown egg cases, which are about 3/8 inch long, in debris or food located in sheltered places. Each female and her offspring can produce nearly 200 cockroaches in one year. Development from a newly emerged nymph to adult can take from 1 to 2 years or more.

Smokybrown Cockroach

The smokybrown cockroach, Periplaneta fuliginosa, is usually found in decorative plantings and planter boxes, woodpiles, garages, and water meter boxes; it may occasionally inhabit municipal sewers. They sometimes invade homes, taking refuge in areas such as the attic. Nymphs are dark brown and have white segments at the end of their antennae and across their backs. Smokybrown cockroaches prefer the upper parts of buildings; they also may live under shingles or siding and sometimes get into trees, shrubs, and other vegetation during summer months. Females carry the dark brown to black egg case, which measures about 3/8 inch long, for about 1 day before dropping it; eggs can quickly hatch in 24 days or take 70 days after being laid, depending on temperature. About 40 to 45 nymphs hatch from a single egg case.

Smokybrown Cockroach Elimination

1. Eliminate or alter any conditions which encourage the presence and/or reproduction of the roaches. These pests thrive in dark, humid areas which have little or no air flow.
2. Spray exterior of structure with Suspend SC, Demon WP or Cynoff WP. These odorless insecticides will give a quick knockdown of bugs while lasting for several weeks, usually yielding about 90 day residual. Spray any crack, crevice or entry point on the outside of the structure. This includes treating around all windows, doors, vents and in weep holes of brick veneer.
Also spray tree trunks, from ground to crotch of tree, but no higher than six feet. All mulched areas should be sprayed with your insecticide.
These exterior surfaces should be treated 3 to 4 times each year.
3. If necessary, spray indoors in the following areas: basements, garages, carports, attics, closets, laundry rooms. Also treat beneath and behind large appliances (refrigerators, stoves, etc.) or other areas where these roaches prefer to hide. (Spraying all of your baseboards with any bug spray is not necessary!) Indoor areas should be treated 2 to 3 times per year.
4. Hollow blocks or other areas such as behind brick walls and along plumbing lines should be treated with Delta Dust. Although many dusts will kill roaches, Delta Dust is water-proof and will not be destroyed by the moist habitat of the Smokybrown as would other dusts. For deeper penetration and better distribution of your insecticide dust, use a Crusader Duster. Delta Dust should be used once each year or as needed.

Wood Cockroaches
Wood cockroaches are a group of minor cockroach pests. They are native to North America. Males are usually plain brown and 1 inch or less in length. Females are shorter and broader than males. Generally, females range in color from light to dark brown, with wings only half the length of the body or shorter. Males are good fliers and are often found around lights at night. Sometimes males fly into buildings. Outdoors, wood cockroaches are found in areas such as wood piles, mulch, and leaf litter. Indoors, wood cockroaches cannot survive very well and are seldom a problem.

Adult males are approximately 1 inch long; females grow to about 3/4 inch long. Males are dark brown; the sides of the thorax and the front half of the wings are margined with yellow. Adult males are fully winged, while females have conspicuous wing pads (actually short wings like that of the female oriental roach), which are functionless. Wings of the male are longer than its body, while wing pads of the female cover only one-third to two-thirds of the abdomen. The males fly swiftly but do not have the ability to sustain themselves in the air for long periods.

Exterior Treatments
Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair. Changing white incandescent bulbs to yellow bulbs around entrance doors may help.

Chemical Control
Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application. The use of residual sprays or aerosol foggers within a structure is of little value in controlling cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy.

Common Cockroach Classifications and Sub-Families

1. The field cockroach, *Blattella vaga* Hebard, is similar to the ____________in appearance, but it occurs primarily outdoors where it feeds on decaying plant materials.

2. The ____________cockroach, *Supella longipalpa* (Fabricius) is about the same size as the German cockroach, but appear " *banded*" because the wings are marked with a pale brown band at the base and another about a third of the distance from the base.

3. Life Cycle: Mated females produce an egg capsule that is attached to the end of the abdomen for up to a month before being dropped a day or so before eggs hatch. Each 5/16-inch-long, brown egg capsule contains ____________ (oothecae) which hatch in 2 to 4 days after being deposited.

4. ___________hatching from eggs are less than 1/8 inch long and wingless. They develop through 6 to 7 stages (instars) over 74 to 85 days (varying with temperature) before becoming adults.

5. There may be __________ generations per year.

6. Some people have _________________to cockroaches or cockroach residues (*e.g.*, feces, body extracts).

7. American Cockroach. Adults of this species are 1 1/2 to 2 inches long. They are the _____________of all the cockroaches common in the World.

8. Both nymphs and adults are shiny, reddish brown with a pale brown or yellow band around the edge of the head and back. The wings of both the ___________ extend slightly beyond the body.

9. Wood cockroaches are usually found in__________, hollow trees or under loose bark. Buildings in wooded areas are prone to have problems with wood roaches during rainy periods

10. The ___________has a great tendency to lose moisture through the cuticle and thus requires water every two to three days.

Common Cockroach Classifications and Sub-Families Answers
1. German cockroach, 2. Brownbanded, 3. 30 to 40 eggs, 4. Nymphs, 5. Four, 6. Allergic reactions, 7. Largest, 8. Male and female, 9. Woodpiles, 10. Smokybrown cockroach

Topic 16- Cockroach Inspection and Treatment Section

Section Focus: We will examine the basics of cockroach related inspection, management and pesticide treatments. At the end of this section, you will be able to understand and describe various cockroach inspection techniques, control and elimination applications including fumigation. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Cockroaches are best controlled through an integrated pest management process of inspection, sanitation, exclusion, and the use of low-toxicity insecticides.

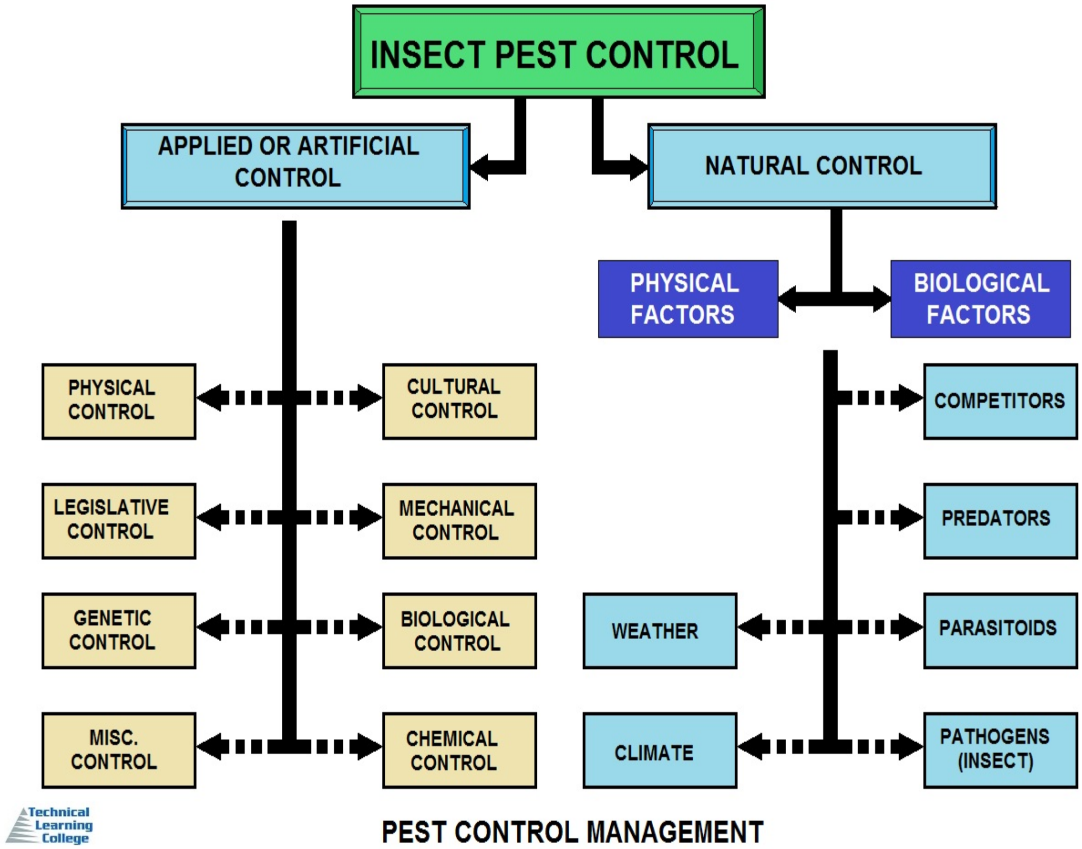
Cockroach Prevention: Exclusion and Sanitation

Principles of Effective Cockroach Control

Before we examine the inspection section, we believe the first step in cockroach control is to keep the insects out of the home or business. Because roaches do not generally survive winter conditions (except for wood roaches), you need not worry about them entering homes directly from outside. Unless you live a warm winter area. However, roaches may be transported into homes on items coming from elsewhere. Old used items are especially likely to carry the pests.

Once a home or business is infested, the object is to deprive roaches of food, warmth, moisture and undisturbed dark cracks and crevices. Keep dishes washed, food in tight containers, garbage in tightly covered cans, dry pet food out of their reach, cracks caulked and gaps around pipes filled with steel wool, caulk, or other sealants.

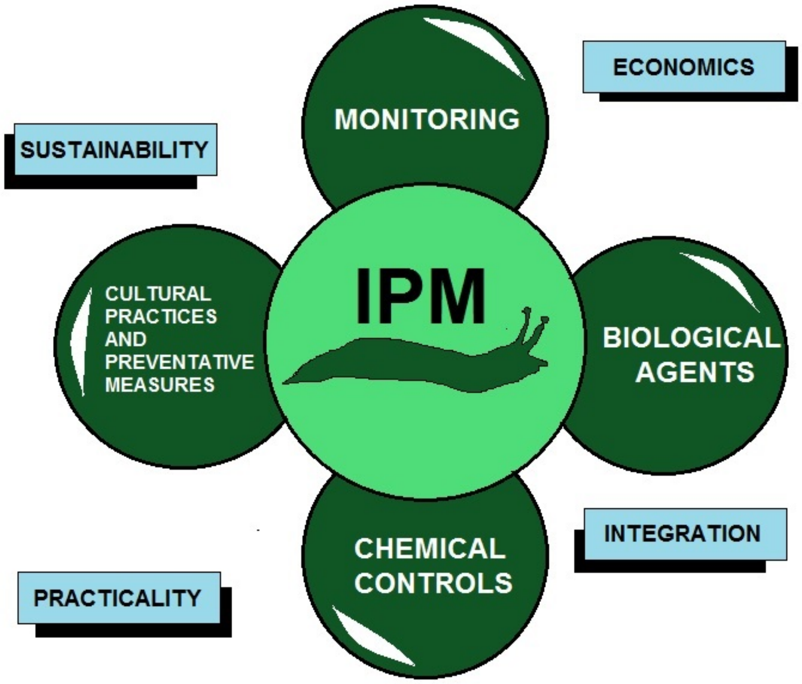
Integrated Pest Management (IPM) Approach



The key to effectively eliminating cockroaches is to follow an Integrated Pest Management (IPM) approach. It includes the following steps:

- An inspection to find where and how serious the infestation is;
- Identification of contributing factors (such as sanitation problems), and taking corrective measures;
- Use of various tools to kill cockroaches and continued monitoring and treatment as needed.

All of these procedures are essential to maintain a cockroach- free living environment. Long term prevention of cockroach infestation is the best means of ensuring a cockroach free environment. This is most easily accomplished by means of exclusion (preventing cockroach entry) and sanitation (elimination of cockroach resources). Not only will these measures prevent a future infestation, they will also help to reduce an existing cockroach problem.



INTEGRATED PEST MANAGEMENT (IPM)

Exclusion - Preventing Cockroach Entry Locations

1. Children can transport cockroaches from school to home in book bags and lunch pails. Inspect these items on a regular basis.
2. Cockroaches migrate easily through multi-unit dwellings via plumbing and electrical connections. Sealing gaps around plumbing, wall outlets and switch plates will prevent cockroaches from migrating from infested units to others.
3. Fiberglass window screen over vent pipes on the roof will prevent cockroaches from migrating up from sewer connections and gaining access to attics and windows.
4. Groceries, produce and other packaged food products may have been stored in infested locations before they were purchased. Make an effort to visibly scan all grocery items for cockroach evidence before putting them away.
5. Guests (adults and children) can often transport cockroaches from their infested home to yours either on themselves or in packages. Limit guest access to specific areas of your home and inspect these areas after they depart.
6. Keep doors and windows closed and screened. Also, caulk cracks and gaps that may allow peridomestic cockroaches to invade from outdoors.
7. Peridomestic (Living in and around human habitations) cockroaches frequently enter homes by coming up through dry drain traps. Periodically run the water in spare bathrooms, utility tubs and toilets to keep the drain trap filled and off limits to cockroaches.

Sanitation Elimination of Food Resources

German cockroaches can remain alive for approximately 2 weeks with no food or water and for 42 days if only water is available. While that time, these creatures are laying eggs for the next generation. Therefore, it is important to realize that cockroaches can survive on tiny amounts of food such as crumbs, grease or food residue.

Customers' Needs List

It is a difficult concern when customers are responsible for unsanitary conditions in which cockroaches thrive. Most of us will see about 70 percent of our treatments are in businesses or homes that are unsanitary. I often make a record of restaurants that I will not eat at after I've preformed a cockroach inspection. There are days that I am unable to find a food related business that I can comfortably eat at. I believe that you as a pesticide professional will do a better job of inspection than most health inspectors and you too will have trouble finding a safe and clean restaurant. Maybe this is possible in a cold climate. I remember inspecting a Chinese fortune cookie making operation, because of the cockroach infestation, I can never eat fortune cookies again.

Ideal Customer's Sanitation List

It is difficult to tell the customer these concerns and most of us do not have the time.

1. All foods products should be resealed after opening, stored in plastic snap-lid containers or kept in the refrigerator.
2. Feed pets at particular times and clean up after every meal. If pets are present, dry food should be kept in re-sealable containers. Do not leave food and water out all the time.
3. Filled indoor garbage containers should be removed from the dwelling immediately and placed in outdoor containers with tight fitting lids or dumpsters.
4. Frequent emptying of sink strainers and running of the garbage disposal and will prevent food build up in the sink drain.
5. Indoor trash containers should be emptied frequently, kept clean both inside and out. Plastic bags lining trash containers can be kept closed with twist ties. This will prevent cockroaches from being attracted to the garbage area. Keeping the area around dumpsters or other outdoor garbage storage areas clean and free of debris will also prevent peridomestic cockroach infestations in the area.
6. Kitchen appliances (toasters, toaster ovens, microwaves, ovens, stoves, and refrigerators) should be kept clean and free of food particles and grease. Additionally, the areas underneath and behind these appliances should be kept grease and crumb free.
7. Regular cleaning of food storage areas and shelves not only eliminates spilled or scattered food but disrupts cockroach populations that may be using the area as a harborage.
8. Regular sweeping/vacuuming of floors and furniture where people eat (i.e. kitchen table or in the living room in front of T.V.) help to eliminate cockroach food sources.
9. Washing dishes immediately after a meal will prevent cockroaches from consuming food residue on dishes. Unwashed dishes are a major source of food for German cockroaches.

Elimination of Moisture Resources

The single most important factor in determining cockroach survival is availability of water. Again, German cockroaches live less than two weeks when there is no supply of free water even if food is abundant. During periods of drought the incidence of peridomestic (Living in and around human habitations) cockroaches indoors will often increase as the large cockroaches invade structures in search of moisture. It is therefore important to eliminate all sources of moisture that contribute to cockroach survival.

Most of this information seems repetitive, however, we need to figure out ever source to an infestation and most of the time, the customers are to blame either knowingly or unknowingly and it is difficult to tell them these concerns.

So, we will master this area and learn to be wise as a serpent and gentle as a dove when describing these concerns during your inspection and price quotes. It is similar to telling a stranger that they have bad breath and it is their fault and trying to be their friend.

Common Moisture Resources

1. Refrigerator: A common source of moisture is condensation under the refrigerator. This area should be frequently wiped dry or, if possible, a pan should be placed under the appliance to collect water. The collection pan should be emptied frequently. Condensation on pipes (under the sink or in wall voids) is also a problem. Insulate these pipes if possible. Or a leaky waterline to the ice maker. This type of leak is generally difficult to find but is a fountain of life to cockroaches.
2. Indoor plants: Be careful not to over-water indoor plants, because excess water is available to cockroaches.
3. Dishware: Glasses, cups and soda cans containing water or liquid residue are common sources of moisture for cockroaches. Be sure not to leave these containers in bedrooms, sinks, on counter tops or other areas. Rinse and invert cups and glasses to dry immediately after use and dispose of soda cans in trash containers.
4. Pet Feeding: Pet drink dishes and aquariums are also sources of moisture. Empty pet water dishes at night when cockroaches are foraging but the pet is indoors or asleep. Aquariums should have tight fitting lids or screens to prevent cockroach entry.
5. Water: Steps should be taken to eliminate places where water collects outdoors (tires, cans, tree holes etc.). This will not only eliminate cockroach moisture sources but also mosquito breeding habitat.
6. Leaks: Tightening loose pipes, patch plumbing leaks and replace used washers in the kitchen sink and bathroom areas. Outdoor water spigots and sprinklers should also be checked for drips and leaks.
7. Sinks: Water left in the sink or bathtub after dish washing or bathing also provides moisture for cockroaches. These sources are eliminated by drying out sinks and bathtubs after use.

Elimination of Harborage Resources

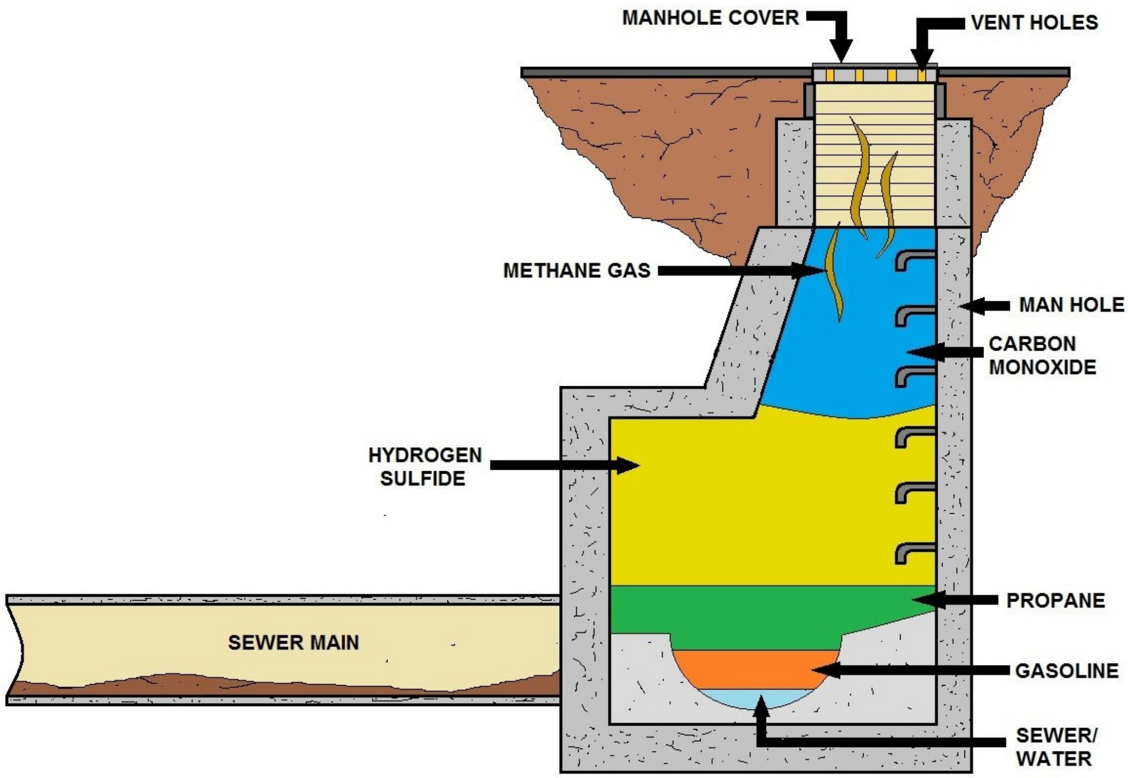
Cockroaches hide in dark narrow cracks and crevices. They tend to gather in corners (in the back of cabinets or drawers, for example) and generally travel along edges such as baseboards. Again, they are most active during the night. The third critical element for cockroach survival is harborage or shelter or clutter. By nature, cockroaches avoid open, well lit areas with frequent air movement. They prefer dark, warm cracks and crevices. Excess clutter provides numerous locations suitable for cockroach habitation. Cockroaches eat many kinds of materials. They are especially fond of starches, sweets, beer, and meat products. They also feed on leather, bakery products, flakes of dried skin, dead animals, and plant materials.

The elimination of these harborages (clutter) is important in controlling infestations. Again, it is difficult to inform the customer of these following concerns, however, many customers will pay you to remedy these concerns. Some applicators do not care or others think these concerns are not essential and that these concerns are basically job security. I have seen many different approaches on these issues. I am at the point of my career to say that, if you are able and have the time, always do the best job you are able to do and consider that you may never return to this customer in the future, but you want to leave a good impression.

Cockroach Access Control Measures

1. Adult cockroaches can fit into cracks only 1.6 mm wide (about 1/16 of an inch). Any small gap or hole that leads to a void is a prime cockroach harboring area. Cracks and crevices of this kind should be sealed with a tube of caulking.
2. Filling in tree holes with cement also eliminates peridomestic cockroach harborage.
3. Keep palm trees free of loose and dead palm branches and remove all palm debris.
4. Keep shrubbery and ornamentals well-trimmed.
5. Outside, remove debris and trash from around the house.
6. Removing clutter (boxes, bags, clothing, toys, food, books, papers etc.) eliminates cockroach harborages and breeding areas. It is essential to keep all areas of the home, especially the kitchen and bathroom, uncluttered and free of useless debris.
7. Stack firewood far away from the house, as this is a prime harborage area for peridomestic cockroaches.

Cockroach Inspection - Introduction



POSSIBLE HAZARDOUS ATMOSPHERES PRESENT IN A CONFINED SPACE (EXAMPLE IS OF A SEWER MAIN)

Cockroaches thrive inside confined spaces like the manhole in the above diagram. Always be careful of dangerous gases and /or lack of oxygen while working inside manholes.

Inspection Equipment

Proper equipment is essential for conducting a cockroach inspection. For inspecting a customer’s business, home or apartment, the following five items are recommended:

1. A flashlight to illuminate dark areas where cockroaches like to hide. To be able to find and identify feces or cockroach habitation, like feeding areas.
2. A mirror with extension arm (such as a dentist’s) to help see hidden areas, like behind sinks, under refrigerators and appliances. Some applicators have video monitoring equipment that attaches to the smart phone. These devices help identify problem pest areas to the customer and are great sales tools.
3. Monitoring traps. We recommend a minimum of six traps but prefer ten traps. We will describe later.
4. A probing, tapping or crevice tool, like a screwdriver, a tool that can probe, tap or open cockroach areas. There are professional probing type tools available.
5. A digital camera. Today’s customers may ask for a digital record of your efforts and these photographs will generally prove your work and keep the customer happy.

The Inspection - Visual Examination

The inspection principles will be similar for rodent inspection and will work for German, brown-banded, oriental and American cockroaches. It will be helpful to get answers from the customer for the following questions.

- Where did you first see cockroaches?
- Where do you see them now?
- Normally, the customer will explain more clues about the infestation and you will need to examine the clues, like wet areas, access to food, etc.

Past Efforts

If you are there for the first time, consider past or present professional pest control efforts. If the previous pest control tactics included the use of insecticides with a strong repellent effect (this includes most of those currently used today), the cockroach infestation may have moved from its original location. In this case, you should spend some time exploring locations where insecticides were not used, like false ceilings, behind walls and other areas above your head. I once found a huge infestation behind a toilet tank.

Map the Area

While performing a detailed examination of the area, take an overall look at the premises, inside and outside. Build a picture of traffic patterns for people. Customers will not understand that you are building this map inside your mind. This operation is similar to inspecting for rodents, termites or bedbugs.

- In particular, where is food brought in?
- Where is it prepared? Where is it eaten?
- How are leftovers and other garbage disposed of?
- Is the trash emptied in a timely manner?

Perhaps the cockroaches hitchhiked into the kitchen with food supplies. Consider food storage and related activities, such as recycling bins and cardboard boxes.

- Could these be encouraging the problem?

If introduction with food is confirmed, try to identify where the cockroaches originally came from.

- Could cockroaches have been brought into the residence by someone who works in infested buildings?
- Are there college kids who frequently move between apartments and home?
- What about sewer drains, roof drains, improper plumbing connections?
- What about grease traps and trash removal?

Cockroaches may be lazy however they are smart and move into residences and businesses from other infested buildings. In apartments, the cockroaches may have first entered from outside or from adjoining units. You should check possible entry points such as around water and drain pipes under the sinks, sewer pipes, steam supply pipes, conduits for electricity or crevices in walls connecting with other infested areas. Identifying the origin of the cockroaches is valuable from the long-term viewpoint to prevent re-infestation.

There are several concerns that you as the inspector need to think about. You will quickly learn how to deal with these concerns. The problem is time. Most applicators are pushed in time.

We are taught to do the job quicker than we are supposed to do. Some of us have to do a poor job unless we have to sell or push a treatment or chemical. In essence, it will take about one year to figure out the basics or cockroach inspection and control, but you will never completely master it with today's treatments.

Dark Locations – Similar to Rodents

Cockroaches are similar to mice and like warm, dark locations near food and water. It is helpful to note all those factors favoring cockroach survival once they have gotten into your home. Since cockroaches need food, look for food sources, such as fresh fruits or vegetables and pet foods. Also, look for food spills or buildup of food material in or under counter tops, stoves and refrigerators. Look in mops and brooms, inside the rims of the floor drain, around the wheels of mobile carts and other similar places. You should also check less obvious food sources, like rodent bait stations, for signs of cockroach activity. Cockroaches aren't killed by rodent baits.

Cockroaches need water as well as food, so check for condensation or leaks providing a water source. Don't forget to consider less obvious sources of water such as planters, pet water dishes and fish tanks.

In addition to food and water, cockroaches need daytime hiding places in which to rest and breed, and these harborages must be identified during the inspection. Once again, use your knowledge of the target pest to focus your efforts. German cockroaches prefer dark crevices close to moisture.

Cockroaches prefer bare wooden surfaces, cardboard or paper because these surfaces are easier to climb and because porous surfaces retain their aggregation pheromone. They will also be found in stacks of paper, grocery bags, letters and other paper items.

Pay particular attention to fixtures made of wood, such as storage shelves, wooden tables and cabinets. Also check behind and under appliances, in the corners of rooms at floor or ceiling level, behind pictures and around the legs or wheels of carts as well as in appliance voids.

Don't forget to inspect suspended ceilings. Sometimes cockroaches become trapped in such things as spider webs, light fittings and partially empty beverage bottles.

Look for every clue you can when identifying the problems. In general, the harder it is to gain access to a potential harborage, the more likely it is to be infested. The simplest method to monitor cockroaches is to visually inspect cockroach hiding places using a flashlight and then place a glue trap.

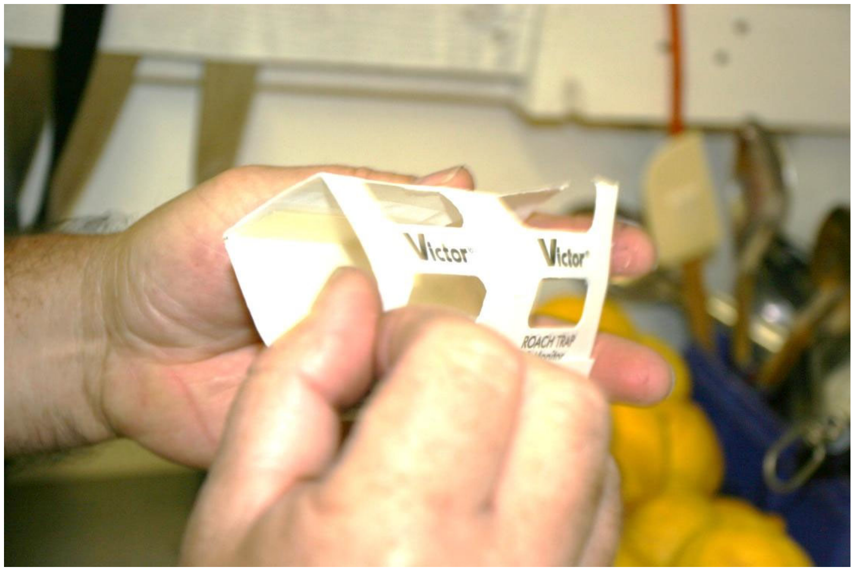
Places such as behind the refrigerator, under the sink, crevices in cabinets and shelves, closet door corners, and bathroom cabinets and closets are especially important. If you are still not sure about the cockroach infestations after a visual inspection, you can use the following monitoring tools.

Placing Traps - Known Infestation Areas
In addition to putting traps in known infestation areas, you must also place enough traps to "cover" the areas of suspected infestation (with German cockroaches this means the kitchen and bathrooms).

To accomplish this, first put at least one trap in each of the following locations:
1) beside or behind the toilet,
2) under the sink in the bathroom,
3) beside the shower or bathtub,
4) under the kitchen sink,
5) behind, under or beside the refrigerator,
6) beside, under or behind the stove,
7) in the back of each kitchen cabinet,
8) beside or under the water heater (if available),
9) behind or beside the washing machine,
10) behind or beside the automatic dishwasher.

Cockroach Control Procedures for a Restaurant Kitchen

Start with a thorough inspection, it is best if the kitchen staff was to do a thorough cleaning the night before the inspection. It is also great if you can be there a couple of hour before the food preparation begins. Always wear gloves during your inspection and treatment. Most technicians do a poor job when dealing with cockroaches, generally because of time limitations. This procedure may work for complete cockroach control for as long as you maintain treatments. This procedure is not a money maker on the first three treatments but you will make money down the road and have a satisfied customer for life and the word of mouth advertising is the best form of advertising.



Set-up your roach traps for monitoring behavior, you can cut these tents in half or use one large trap. It is best to place these devices these everywhere, including in the ceiling. These traps will tell you volumes of data about our pests, tents are great control and monitoring tools. A lot of these procedures are suggestions and the best rule is to follow the pesticide or device directions. Once in a while, I will add a dab of roach killing gel or bait to the trap or tent. The first treatment after inspection and proper pest identification is to apply the roach hormone growth regulator and dust all the cracks and crevices with boric acid or equivalent chemical and use a flushing spray. Return back in one week with the following tools (*see below*). Now it is time to lay down the hammer and smash the roaches. You don't have to use the same pesticide products as I do; there are many good and comparable pest controlling products. I prefer these products below and they are readily available in my area.

After the first treatment, return again in 7-10 days and give the roaches the chemical treatment. Return with different chemical treatments every three to six months. On the top, I am using Maxforce Magnum Roach Killer Bait Gel for it works very well. In simple terms, cockroaches love grease, they prefer a dirty kitchen, they will thrive on the back of cooking areas and eat the grease forever but if the kitchen is professionally cleaned, the roaches will eat the bait gel. Cockroaches are just like humans and they prefer a hot T-bone steak over a cold piece of pizza and that is how they look at killer bait gels. Cockroaches love electrical boxes and electrical equipment, there are many reasons; the areas are warm and have a vibration similar to their natural homes. Just apply a thin dap of killer bait gel to all electrical boxes and vents. FYI, I have found the same of bedbugs. I also dust with boric acid to add a little extra killing power for those hard to reach roaches.

Sometimes you have to hammer roaches with a spray. I like CB-80 Extra for two reasons, one is a great flushing agent and two it leaves little or no residual. One telltale sign of cockroaches is their musky smell, pull out a refrigerator and smell around the compressor, you should smell the roaches if they are there. It takes a few years but you will recognize the odor of roaches, the most common is German Browns, they are easy to kill, they are not like scorpions or bed bugs. The only effective method of cockroach control is keeping your kitchen super clean and very few people do that, which is one reason why we have job security and roaches will never die.

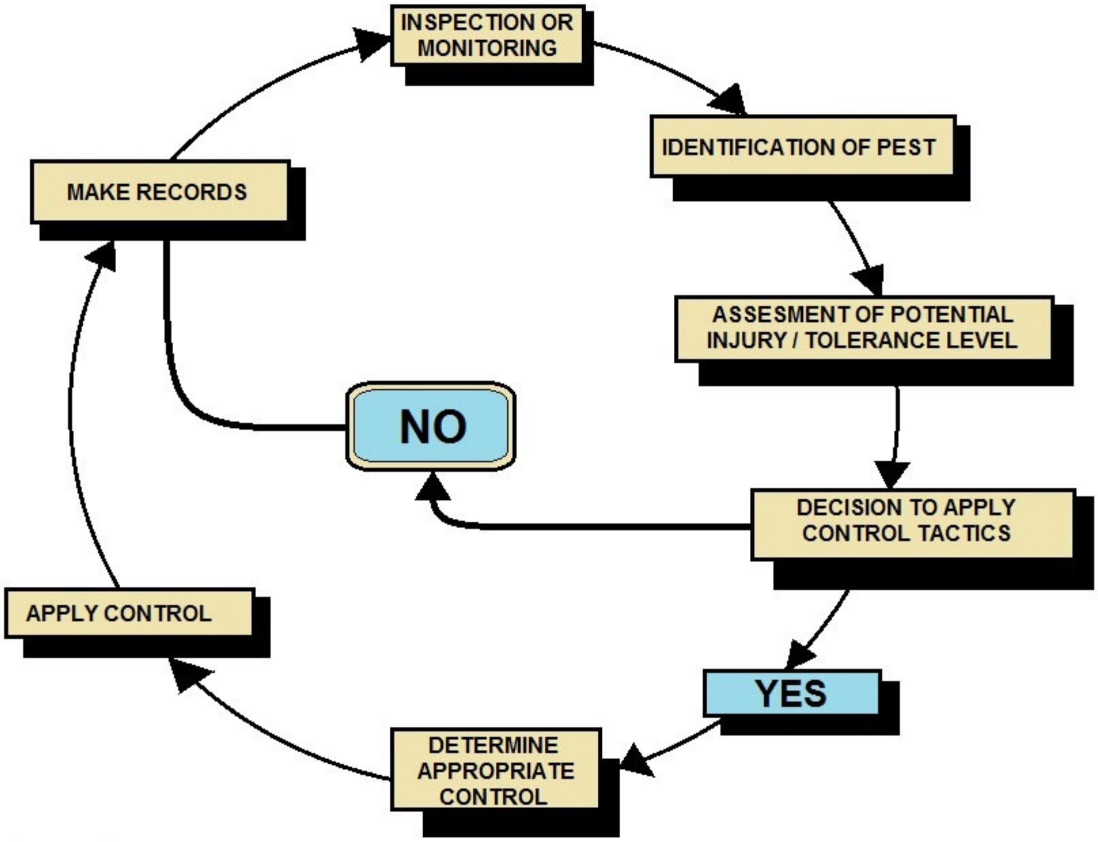
Bookkeeping is super important for both the customer and for you. I like to make a customer log book and leave it at the restaurant with my procedures and my findings. The health inspectors love to see these log books and the customer likes to be able to prove that they are trying to fight these pests. I always write that “Kitchen needs to be cleaned and the sides, backs and the bottoms of equipment need to be cleaned on a daily basis. These log books are excellent methods of keeping your customer for a longtime. Customers actually like that you will document your treatments and successes. I want the roaches to eat the killer bait and not the grease. Also spray the outside and entry ways with your B and G and/or Backpack sprayer.

Return every 7-10 days and inspect traps. There are many different traps; I like both pheromone and plain type of traps. One method roaches and rats get in to the building is through drop-ceilings. You will need to treat the inside of a drop-ceiling with a heavy treatment the first couple of times if roaches are returning.

Roaches love strip malls and shell buildings, so be aware of their advanced minds and outsmart them. Roaches also love to eat at grease traps and outdoor grease storage areas. I have seen many customers that were very happy that my treatment plans worked and they always tell others about my service. The big pesticide chains will not do this detailed service, but will send a “return or call back” out to take care of the problem.

Spend the extra hour and hammer the roaches on your first two and six month treatments, the other additional treatments will only take a few minutes. I calculated my costs for a roach infested kitchen, in the first two visits, it cost me approximately $60 in chemical and traps and $100 in time and mileage. I made $75 and while losing $85. But I gained 14 more accounts and now I return each week and make $35 profit per treatment. I think this is called a “lost leader” in the grocery market business but I have 15 more customers for the rest of their lives.

IPM Methods for Cockroaches (*Types of Pest Control)*



INTEGRATED PEST MANAGEMENT (IPM)

Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.

The IPM approach can be applied to both agricultural and non-agricultural settings, such as the home, garden, and workplace. IPM takes advantage of all appropriate pest management options including, but not limited to, the judicious use of pesticides. In contrast, organic food production applies many of the same concepts as IPM but limits the use of pesticides to those that are produced from natural sources, as opposed to synthetic chemicals.

IPM is not a single pest control method but, rather, a series of pest management evaluations, decisions and controls. In practicing IPM, growers who are aware of the potential for pest infestation follow a four-tiered approach.

The four steps include:
Set Action Thresholds
Before taking any pest control action, IPM first sets an action threshold, a point at which pest populations or environmental conditions indicate that pest control action must be taken. Sighting a single pest does not always mean control is needed. The level at which pests will either become an economic threat is critical to guide future pest control decisions.

Monitor and Identify Pests
Not all insects and other living organisms require control. Many organisms are innocuous, and some are even beneficial. IPM programs work to monitor for pests and identify them accurately, so that appropriate control decisions can be made in conjunction with action thresholds. This monitoring and identification removes the possibility that pesticides will be used when they are not really needed or that the wrong kind of pesticide will be used.

Prevention
As a first line of pest control, IPM programs work to manage the crop, lawn, or indoor space to prevent pests from becoming a threat. In an agricultural crop, this may mean using cultural methods, such as rotating between different crops, selecting pest-resistant varieties, and planting pest-free rootstock. These control methods can be very effective and cost-efficient and present little to no risk to people or the environment.

Control
Once monitoring, identification, and action thresholds indicate that pest control is required, and preventive methods are no longer effective or available, IPM programs then evaluate the proper control method both for effectiveness and risk.

Effective, less risky pest controls are chosen first, including highly targeted chemicals, such as pheromones to disrupt pest mating, or mechanical control, such as trapping or weeding. If further monitoring, identifications and action thresholds indicate that less risky controls are not working, then additional pest control methods would be employed, such as targeted spraying of pesticides. Broadcast spraying of non-specific pesticides is a last resort.

Six Basic Components

An IPM system is designed around six basic components: The US Environmental Protection Agency has a useful set of IPM principles.

1. Acceptable pest levels: The emphasis is on control, not eradication. IPM holds that wiping out an entire pest population is often impossible, and the attempt can be economically expensive, environmentally unsafe, and frequently unachievable. IPM programs first work to establish acceptable pest levels, called action thresholds, and apply controls if those thresholds are crossed. These thresholds are pest and site specific, meaning that it may be acceptable at one site to have a weed such as white clover, but at another site it may not be acceptable. By allowing a pest population to survive at a reasonable threshold, selection pressure is reduced. This stops the pest gaining resistance to chemicals produced by the plant or applied to the crops. If many of the pests are killed then any that have resistance to the chemical will form the genetic basis of the future, more resistant, population. By not killing all the pests there are some un-resistant pests left that will dilute any resistant genes that appear.

2. Preventive cultural practices: Selecting varieties best for local growing conditions, and maintaining healthy crops, is the first line of defense, together with plant quarantine and 'cultural techniques' such as crop sanitation (e.g. removal of diseased plants to prevent spread of infection).

3. Monitoring: Regular observation is the cornerstone of IPM. Observation is broken into two steps, first; inspection and second; identification. Visual inspection, insect and spore traps, and other measurement methods and monitoring tools are used to monitor pest levels. Accurate pest identification is critical to a successful IPM program. Record-keeping is essential, as is a thorough knowledge of the behavior and reproductive cycles of target pests. Since insects are cold-blooded, their physical development is dependent on the temperature of their environment. Many insects have had their development cycles modeled in terms of degree days. Monitor the degree days of an environment to determine when is the optimal time for a specific insect's outbreak.

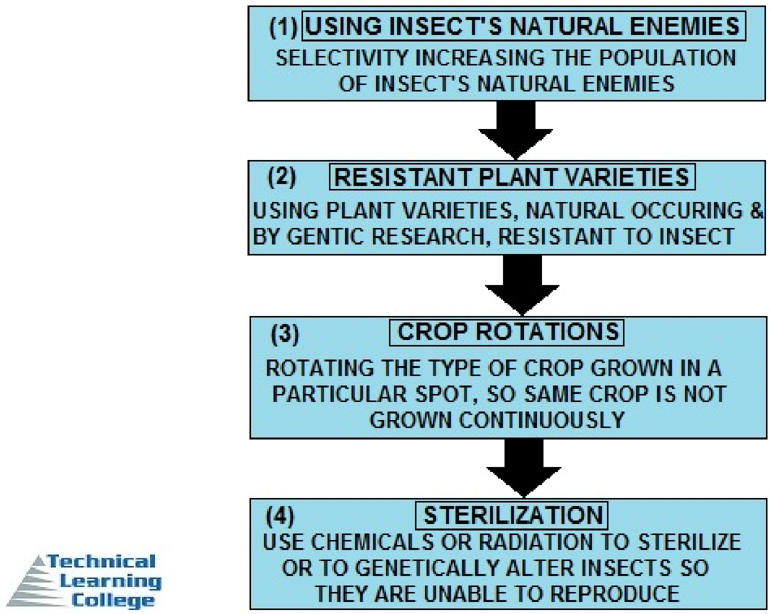
4. Mechanical controls: Should a pest reach an unacceptable level, mechanical methods are the first options to consider. They include simple hand-picking, erecting insect barriers, using traps, vacuuming, and tillage to disrupt breeding.

5. Biological controls: Natural biological processes and materials can provide control, with minimal environmental impact, and often at low cost. The main focus here is on promoting beneficial insects that eat target pests. Biological insecticides, derived from naturally occurring microorganisms (e.g.: Bt, entomopathogenic fungi and entomopathogenic nematodes), also fit in this category.

6. Responsible Pesticide Use: Synthetic pesticides are generally only used as required and often only at specific times in a pests' life cycle. Many of the newer pesticide groups are derived from plants or naturally occurring substances (e.g.: nicotine, pyrethrum and insect juvenile hormone analogues), but the toxophore or active component may be altered to provide increased biological activity or stability. Further 'biology-based' or 'ecological' techniques are under evaluation.

BIOLOGICAL CONTROL METHODS

FOUR AREAS OF BIOLOGICAL PEST CONTROL



Main Focus of IPM Programs
An IPM regime can be quite simple or sophisticated. Historically, the main focus of IPM programs was on agricultural insect pests. Although originally developed for agricultural pest management, IPM programs are now developed to encompass diseases, weeds, and other pests that interfere with the management objectives of sites such as residential and commercial structures, lawn and turf areas, and home and community gardens.

IPM is applicable to all types of agriculture and sites such as residential and commercial structures, lawn and turf areas, and home and community gardens.

Reliance on knowledge, experience, observation, and integration of multiple techniques makes IPM a perfect fit for organic farming (sans artificial pesticide application). For large-scale, chemical-based farms, IPM can reduce human and environmental exposure to hazardous chemicals, and potentially lower overall costs of pesticide application material and labor.

1. Proper identification of pest - What is it?
Cases of mistaken identity may result in ineffective actions. If plant damage due to over-watering is mistaken for fungal infection, spray costs can be incurred, and the plant is no better off.

2. **Learn pest and host life cycle and biology.**
At the time you see a pest, it may be too late to do much about it except maybe spray with a pesticide. Often, there is another stage of the life cycle that is susceptible to preventative actions. For example, weeds reproducing from last year's seed can be prevented with mulches. Also, learning what a pest needs to survive allows you to remove these.

3. Monitor or sample environment for pest population - How many are here?
Preventative actions must be taken at the correct time if they are to be effective. For this reason, once the pest is correctly identified, monitoring must begin before it becomes a problem. For example, in school cafeterias where roaches may be expected to appear, sticky traps are set out before school starts. Traps are checked at regular intervals so populations can be monitored and controlled before they get out of hand. Some factors to consider and monitor include: Is the pest present/absent? What is the distribution - all over or only in certain spots? Is the pest population increasing or decreasing?

4. Establish action threshold (economic, health or aesthetic) - How many are too many?
In some cases, a certain number of pests can be tolerated. Soybeans are quite tolerant of defoliation, so if there are a few caterpillars in the field and their population is not increasing dramatically, there is not necessarily any action necessary. Conversely, there is a point at which action must be taken to control cost. For the farmer, that point is the one at which the cost of damage by the pest is more than the cost of control. This is an economic threshold.
Tolerance of pests varies also by whether or not they are a health hazard (low tolerance) or merely a cosmetic damage (high tolerance in a non-commercial situation).

Different sites may also have varying requirements based on specific areas. White clover may be perfectly acceptable on the sides of a tee box on a golf course, but unacceptable in the fairway where it could cause confusion in the field of play.

5. Choose an appropriate combination of management tactics
For any pest situation, there will be several options to consider. Options include mechanical or physical control, cultural controls, biological controls and chemical controls. Mechanical or physical controls include picking pests off plants, or using netting or other material to exclude pests such as birds from grapes or rodents from structures. Cultural controls include keeping an area free of conducive conditions by removing or storing waste properly, removing diseased areas of plants properly. Biological controls can be support either through conservation of natural predators or augmentation of natural predators.

Augmentative control includes the introduction of naturally occurring predators at either an inundative or inoculative level. An inundative release would be one that seeks to inundate a site with a pest's predator to impact the pest population. An inoculative release would be a smaller number of pest predators to supplement the natural population and provide ongoing control.

Chemical controls would include horticultural oils or the application of pesticides such as insecticides and herbicides. A Green Pest Management IPM program would use pesticides derived from plants, such as botanicals, or other naturally occurring materials.

Inside a large sewer main looking for cockroaches.

6. Evaluate results - How did it work?
Evaluation is often one of the most important steps. This is the process to review an IPM program and the results it generated. Asking the following questions is useful: Did actions have the desired effect? Was the pest prevented or managed to farmer satisfaction? Was the method itself satisfactory? Were there any unintended side effects? What can be done in the future for this pest situation? Understanding the effectiveness of the IPM program allows the site manager to make modifications to the IPM plan prior to pests reaching the action threshold and requiring action again.

Elimintion Keys Summary

Prevention
Entry and establishment of roach colonies can be prevented by close inspection of incoming merchandise, such as food boxes, beverage cartons, appliances, furniture and clothing.

Caulking or puttying areas such as cracks and crevices around kitchen cabinets, bathtubs, water and plumbing pipes, cracks on floors and walls, and exterior windows and doors can eliminate most hiding places and help reduce the cockroach population. Other structural modifications, such as weather stripping and pipe collars, also help to reduce cockroach entry and establishment.

Sanitation
Good housekeeping is the most important factor in preventing and controlling cockroach populations. Cockroaches cannot live without food, water and shelter. Do not allow food particles to remain on shelves or floors.

Dishes should not be left unwashed after a meal, particularly overnight. Clean areas under refrigerators, stoves, sinks and furniture regularly to remove bits of food that have accumulated. If pets are fed indoors, do not leave food in their dishes after feeding, especially overnight. Store pet food in tight containers, and clean litter boxes frequently.

Keep all food items covered or in a refrigerator at all times between uses. Empty garbage and waste containers frequently and keep refuse in a covered container away from the residence.

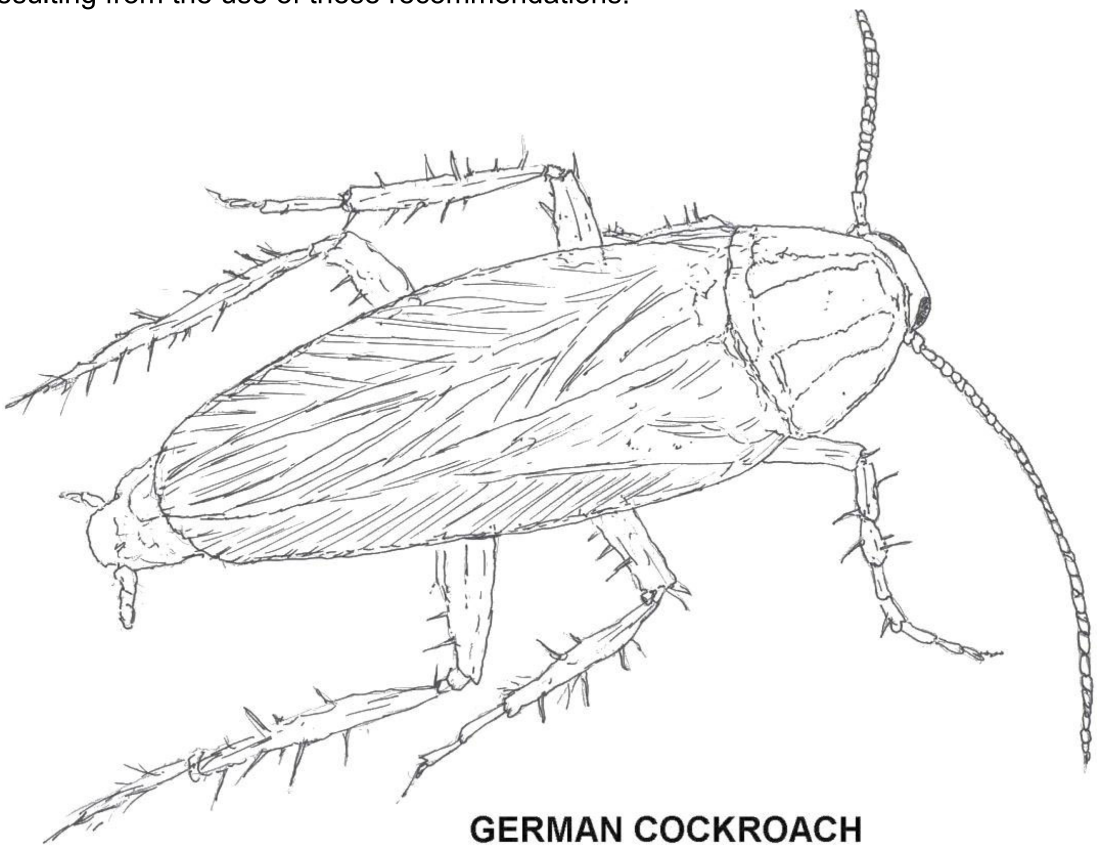
If possible, prevent cockroach access to water sources. Common sources include leaking faucets and pipes, drains, toilet tanks, wash basins and sink traps, aquaria and water-filled tubs. Pets' water dishes, beverage bottles or cartons, and pipe condensation can provide an adequate water supply for roaches. Roach breeding is encouraged by clutter. Avoid unnecessary storage of corrugated paper boxes, piles of paper bags, newspaper, magazines, and soiled clothing and rags.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator’s legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded.

No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.



GERMAN COCKROACH

Cockroach Inspection and Treatment Section Post Quiz

Fill in the missing part.
1. The single most important factor in determining cockroach survival is availability of this ____________________.

2. The elimination of these harborages (clutter) is important in controlling this __________________________.

3. Cockroaches prefer bare wooden surfaces, cardboard or paper because these surfaces are easier to climb and because porous surfaces retain which missing term.

4. Return every ___________ days and inspect cockroach traps.

5. What missing term is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices?

6. What missing term type of pesticides are generally only used as required and often only at specific times in a pests' life cycle?

7. Caulking or puttying areas such as ____________ around kitchen cabinets, bathtubs, water and plumbing pipes, cracks on floors and walls, and exterior windows and doors can eliminate most hiding places and help reduce the cockroach population.

8. What missing term sometimes suffices as the only treatment for cockroaches, but is most often a supplemental treatment?

9. What missing term alone may not provide a high degree of control, but when used with a residual spray or dust, a high degree of control can be achieved?

10. The active ingredient in which product is Cypermethrin 40.0%; it may be used inside or outside of the house?

Cockroach Inspection and Treatment Section
1. Water, 2. Infestations, 3. Aggregation pheromone, 4. 7-10, 5. Integrated Pest Management (IPM), 6. Synthetic, 7. Cracks and crevices, 8. Insecticide dust, 9. Non-residual spray, 10. Demon WP

Topic 17- Pesticide Applicator Section

Section Focus: We will examine the basics of pesticide applicator treatments. At the end of this section, you will be able to understand and describe various cockroach control and elimination applications including fumigation. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Cockroaches are best controlled through an integrated pest management process of inspection, sanitation, exclusion, and the use of low-toxicity insecticides.

Pesticide Applicator Observations

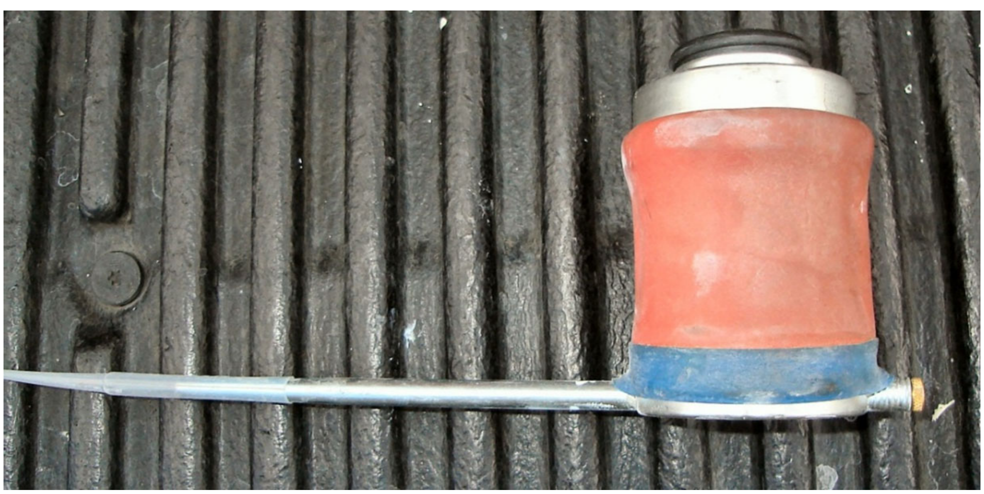
The following are some of my following little observations that we've noticed during my years of teaching. We do not endorse any of the pesticide products.

Right photograph, here is a hand compress spray applicator. Known in the industry as a B&G sprayer. This sprayer will apply most liquid products. A necessary tool for any applicator. Many applicators will have several backpacks with various chemical treatments.

Most applicators have gone to a backpack style product applicator; this is your primary moneymaking tool if properly utilized. I said "product" and not "chemical" or "pesticide". For some reason, customers prefer the word "product" or "treatment" especially when you are applying pesticides. Here is my commentary, for some unknown reason, a majority of the younger applicators are doing a horrible job at applying product and conducting customer service. The larger firms are going through several new hires and only keeping a few of their trainees. This process is costing companies thousands of dollars and losing customers and I can't figure it out.

One suggestion, this type of job requires lots of professionalism and customer service and when we run from one job to another, we start losing focus and soon "burn out".

The item above is often referred to as a "Centrobulb" or duster. This is a brand name and many variations are found. It is a simple tool to apply powder, dust or granular baits. An insecticide duster delivers a fine application of your favorite insecticidal dust. Get one that is non-conductive to electrical lines and switches. I have noticed that applicators will utilize this tool and proper product in areas that are wet or receive rain. This is a good use of product and good idea.



The above photograph is a Crusader Duster or dust applicator and is great for voids in walls or cracks and crevices. Just pour your product in the top and squeeze the product into the cracks or inside switch plates. You've got to get in the pest's home to kill them! Notice the plastic tip so that you don't get an electric shock. This moneymaking tool is great to kill cockroaches, bees or termites. I've heard enough complaints from applicators that they are unable to kill certain pests. Cockroaches are one of the easiest to kill if you can get product on them.

Right photograph, I like to call this my coffee pot type of dispenser. It is a hand held compressed air spot applicator for indoor use.

Phantom or equivalent products works like dynamite on ants and termites alike. Notice the two red backpacks on this truck. Always have a backup backpack. Always follow the pesticide label's instructions and not my comments or suggestions. Some of my suggestions may be illegal in some areas or for certain products. Always follow the label!

Bottom photograph, Drax Gel (i.e. - Orthoboric acid 5%): Indoor ant bait in gel form. The "double barrel" syringe delivers both sugar and protein baits in one easy application. Bait can be placed in small amounts to cracks, crevices and other areas where conventional bait stations cannot be used.

We have found excellent control of household ants by combining Drax Gel with FluorGuard bait stations. This ant bait combo gives you quick control of indoor ant populations. You will often find ants inside areas that have cockroach infestations.

Utilizing the same application gun, is an example of an ant bait which is the ideal means of targeted elimination of ant infestations. Baits are used to kill the entire colony, not just foraging workers. If the ants bite such as fire ants or if they are carpenter ants this is the product you need. The granules are unobtrusive, ready-to-use, and take less time to apply than conventional insecticides.

Termidor

Termidor is applied at very low rates. Typically, the active ingredient (fipronil) is just 0.06% of the solution, a concentration much lower than that of older liquids and less than most insecticides. For an average home treatment, only about 8 ounces of the active ingredient is actually used. Keep in mind, too, that since 1995, fipronil has been used around the world for flea and tick control on household pets and on agricultural crops to protect food supplies. Termidor has virtually no odor, which means you and your family won't notice a thing. Termidor is made from a revolutionary new non-repellent or "undetectable" chemical technology treatment. That means termites cannot see, smell, taste or avoid Termidor. Instead they contact, ingest, and share it with their nestmates. This is in sharp contrast to older liquid termite controls, which rely on repellent barriers that termites can finds breaks in or avoid completely. Mix this in your backpack and never mix with a contact killer. Always have a backup backpack. Always follow the pesticide label's instructions and not my comments or suggestions. Some of my suggestions may be illegal in some areas.

Cockroaches have been here since Adam and Eve and at one time larger in size that today's little size. As an applicator, you will see things that will set you right. Because of your route, you may never eat again at a certain restaurant. I've seen such large infestations in homes and restaurants. But this product has shown success in killing those little creatures. Place Avert cockroach bait into cracks and crevices; holes; pipe chases; undersides of furniture; under drain plates; in or under trash containers; hidden surfaces around sinks and storage areas; behind baseboards; around doors and windows; inside, behind and under cabinets, drawers and shelving; under and behind appliances such as stoves and refrigerators; and in attics and crawl spaces. Also apply in points between different elements of construction, between equipment and floors, openings leading to voids and hollow spaces in walls, equipment legs and bases and crawl spaces where roaches hide. During follow-up applications, inspect bait placements and re-apply when necessary. Care should be taken to avoid depositing cockroach bait onto exposed surfaces. If gel contacts an exposed surface, remove gel and wash exposed surface. This product may also be used in food/ feed areas of food/ feed handling establishments. Believe it or not, this little tube is good for several applications. Let's get it right and make some money and keep those customers.

Roach baits are formulations that are attractive to roaches and (when eaten by the insect) are lethal to roaches. There are different types of baits that can be used, depending on roach species and area to be baited. The basic baits covered in this article are bait stations, bait gels and granular baits. Roach bait stations can be used indoors or outdoors; indoor use is usually recommended. Roach bait gels can be used indoors and can also be used on the exterior surfaces of buildings. Granular baits are usually used outdoors (in mulched areas where larger roaches breed or hide) but can also be used in attics or wall voids.

For best results, do not combine contact insecticides with baits. (A contact insecticide is a granule, liquid spray or aerosol that is used to directly kill targeted pests.)

Two bad things may happen when you use a contact insecticide in the same area where baiting programs are implemented: your bait is contaminated and any domino effect will be neutralized. If you contaminate your roach bait with another insecticide, the bait will no longer be attractive to the targeted roach population. If you kill a roach with an insecticide spray, it will die before it passes the bait on to the rest of the roach population, thus killing your domino effect. The same is true when baiting for ants. You want the foraging worker ants to carry your bait back to the nest where all ants will consume the bait.

Many people are concerned when they see the amount of active ingredients in an insect bait. These people think that they are not getting their money's worth because the amount of active ingredients (insecticide or killing agent) seems to be very low. When baiting roaches, ants, silverfish or crickets, you do not want to see large amounts of active ingredients in the formulation. If insecticide levels are too high (in an insect bait), the targeted pest will be repelled instead of being attracted to the bait. The low amount of active ingredients in a roach bait (or other insect baits) is an attractive property to many people who wish to use as little insecticides as possible.

While I am on the subject, here is a super insect growth regulator. An insect growth regulator is by definition a juvenile hormone mimic, a material that inhibits the growth or maturity of certain insect pests. An insect growth regulator (IGR) is an important pest management tool because it helps to reduce, eliminate or prevent infestations of targeted pests without the use of conventional contact insecticides, thus reducing or eliminating the need for pesticides in homes, hospitals, restaurants, warehouse or any area where certain pests are not welcome.

Hydroprene is an IGR that was first introduced to the pest control industry under the brand name Gencor IGR. Gencor was used to help prevent or control populations of indoor roaches, most commonly used against German cockroaches. Always have a backup backpack. Always follow the pesticide label's instructions and not my comments or suggestions. Some of my suggestions may be illegal in some areas.

Although the name has changed from Gencor to Gentrol, the active ingredient is still Hydroprene. The label for this product has been broadened to include not only roaches (cockroaches) but also many pantry pests, also known as stored product pests. The only stored product pest that does not react well to Hydroprene is the Cigarette Beetle.

This particular beetle is affected by Methoprene, another IGR that is widely used in indoor flea control programs. The Methoprene products used by professional pest control operators are sold under the brand name of Precor.

When cockroaches are exposed to Gentrol (any form or type) people usually report seeing crippled, deformed or otherwise odd looking roaches. These deformities are to be expected. Young roaches (also called cockroach nymphs) have an exoskeleton or outer shell. (Mammals have an internal skeleton or bone structure.) As roaches in their nymphal stage grow, their exoskeleton or outer shell becomes too small to contain the insect. As they reach the limits of their exoskeleton a new, flexible exoskeleton forms beneath the old one and the old "shell" splits open to allow the nymphs to molt. This transition denotes what is called a different instar or stage of development.

Delta Dust

Delta Dust (i.e. Deltamethrin .05%) I have found great success inside wall voids. It will kill cockroaches and ants and that is good enough for me. This odorless, non-staining product is the world's only water-proof insecticide dust!

Besides indoor and outdoor applications, it can also be used on ornamental plants. When left undisturbed, Delta Dust kills crawling insects up to eight months.

Because it is water-proof, this insecticide dust will not absorb moisture (which destroys other dusts) and it will not clump. Provides quick control of ants, bees (especially carpenter bees), cockroaches, fleas, silverfish, ticks, and numerous stored product pests. Also an invaluable tool for controlling Boxelder Bugs, Ladybugs, White Footed Ants and Pavement Ants. Deltamethrin is a synthetic pyrethroid insecticide.

We do not endorse any product but ExciteR is one of my cricket killers of all time. Once you spray this product, you'll see every type of critter run for its life. This is a 6% concentrate of liquid pyrethrin used for fogging and spraying.

Using 1 to 4 ounces per gallon, Exciter can be used alone (in a fogger, mister or pump sprayer) and can also be used as an additive to other insecticides (Malathion, Permethrin, Cypermethrin) for the quick knock-down of insect pests. When used alone, Exciter does not have a long residual.

Always have a backup backpack. Always follow the pesticide label's instructions and not my comments or suggestions. Some of my suggestions may be illegal in some areas.

EXCITER
PYRETHRIN EXAMPLE

Prescription Treatment Brand Cy-Kick CS is a flowable concentrated controlled release Cyfluthrin. Simply mix 1-3 oz. per gallon of water and spray liberally along baseboards, into cracks and crevices, etc. Cy-Kick is also used as an outdoor perimeter or lawn treatment. Virtually odorless and very long lasting. Cy-Kick is the choice of many professional pest companies it is good but not cheap. It will also kill scorpions.

NiBan - FG

Another commonly found pesticide product is NiBan - FG. Niban FG (e.g. Orthoboric acid 5.0 %): Weather resistant bait for the control of ants, carpenter ants, cockroaches, crickets, mole crickets, and silverfish for both interior and exterior use, for use in and around Homes, Apartments, Garages, Public and Private Institutions, Schools, Hotels, Hospitals, Warehouses, Supermarkets, Restaurants, and Food Processing Plants. Apply at a rate of 4 pounds per 1000 square feet (6 ounces per 100 square feet) of surface area. Spread evenly in crawl spaces, attics, and drop ceilings, cellars with dirt or gravel floors. In warehouses, garages and basements, concentrate application along walls and baseboards. Apply in inaccessible areas such as cracks and crevices where insects may hide. Reapply as necessary. Always have a backup backpack. Always follow the pesticide label's instructions and not my comments or suggestions. Some of my suggestions may be illegal in some areas.

When baiting for roaches, crickets or silverfish in cracks and crevices, Niban FG is easy to apply with a Crusader Duster. This professional duster enables you to penetrate deep into the hiding places of insect pests. When baiting outdoors only, Niban G is the best. Niban G is a larger granule, capable of withstanding outdoor conditions for longer periods. When treating for carpenter ants outdoors, consider using the larger granule size.

Talstar One

Talstar One is the new label name for Talstar concentrate. In the past there were several different labels for general categories of pest control in lawns, shrubs, ornamentals, indoor pest control in homes and other areas of pest management concerns. Talstar One has the label you need for controlling the many different pests that Fipronil is known to effectively eliminate or control.

Lawn pests are listed with three different application rates allowed by the pesticide label: Low Rate (0.18 to 0.25 fluid ounces per 1,000 square feet), Medium Rate (0.25 to 0.50 fluid ounces per 1,000 square feet) and High Rate (0.50 to 1.00 fluid ounces per thousand square feet.) Special comments provided for Armyworms, Cutworms, Sod Webworms, and adult Annual Bluegrass Weevil, Banks Grass Mite, adult Billbugs, adult Black Turfgrass Ataenius, Chinch Bugs, Mites, Flea larvae, Imported Fire Ants, adult mole cricket, mole cricket nymphs and ticks.

Keys for Cockroach Control and/or Elimination

Chemical Control
Cockroaches have been the target of many insecticides over the years but they have developed resistance to several of them. Attempts to use pheromones as sex lures or to sterilize male cockroaches have thus far not proved practical on a large scale.

Sprinkling abrasives such as diatomaceous earth to penetrate their protective cuticles may work in individual households as a nonpoisonous alternative. Once the cuticle is abraded, the roaches die of dehydration. Also effective is boric acid powder, which is both abrasive and poisonous to cockroaches. The best way to prevent cockroaches from multiplying is to keep a clean house and block their access to water, which they need to survive.

American cockroaches are very easy to keep and rear in the laboratory and make excellent subjects for experimentation because of their large size and generalized morphology. They have been the subject of countless studies that have tremendously increased our understanding of insect biology. At least two inoffensive species of cockroaches are kept as pets. These are the large, winged Brazilian cockroach and the Madagascar hissing cockroach.

Treatment Methods
The disadvantage is that the treatments need to be where the roaches are hiding. Cockroaches have been seen thriving less than a foot away from a treated surface. Their path of feeding and moving to and from shelter never crossed the treated surfaces. This enabled them to live virtually on top of treated areas and yet still survive.

Cracks and Crevice
When roaches began to build resistance to chemicals and manufacturers designed their products with less volatility, new packaging and treatment techniques became necessary. These new trends became known as "***crack and crevice***".

Basically, c/c means applying the chemical into the cracks and crevices suspected of harboring roaches. There are two types of products commonly used for this purpose: dust and aerosol. In fact, a good pest control technician should be able to get roach control with nothing more than dust if he or she knows where to do the application. ***Drione Dust*** has solved many roach problems. Apply it in cracks and crevices, behind cabinets and major appliances, in wall voids and electric outlets. This requires a lot of work and this product can be messy to work with, but provides the fastest results possible when used properly. Use a ***Crusader Hand Duster*** for the application. Since dust can be messy to work with, aerosol products became popular throughout the 1980's.

Although not as popular as when they first came out, aerosols offer a clean, ready to use formulation which is effective. PT-280 uses Orthene as an active ingredient which is still the least resistant chemical available for roach control. On a special note, don't think you can substitute Boric Acid or a can of "***Raid***" for either of the products mentioned above.

The professional line of products which is discussed are truly effective and not commonly available. Their active ingredients are effective because insects have not been able to build resistance.

There are several stories of super roaches and the fact that "***even the bugman***" couldn't get rid of "***my***" roaches, but what it all boils down to is the application method and the choice of product. If the products used are the ones as mentioned above and the treatment is thorough and complete, there is little chance of any roach surviving nor of re-infestation. Most insects, certainly roaches, cannot live where Drione has been applied. That being said, all you need to do is apply it wherever roaches want to be. This process of eliminating their nest sights eliminates their population.

Common names (the names found on the list of active ingredients) of other effective pesticides include: propoxur (Baygon), cyfluthrin, permethrin, deltamethrin, and tetramethrin. A variety of formulations may be available, including sprays (liquid or wettable powders), aerosol sprays, baits or dust. No single chemical or formulation will control all cockroaches.

Some German cockroach infestations are resistant to one or more insecticides. Apply insecticides only to cracks, crevices, or unexposed surfaces, and not beyond the point of runoff. Avoid spraying carpets, wallpapers, or other furnishings that might be stained.

The reason they appear to be "***resistant***" in most cases is that they are simply avoiding treated areas. This can happen when products are mixed at higher rates or when applicators fall victim to treating the same areas over and over again. The roaches which survive all these applications are the ones which are going where the applicator has failed to treat.

Today, these problems have been all but eliminated with the latest treating methods**.** These new methods are both safer and easier to do. Although spraying has long been the main method to get roach control, baiting has become a legitimate method as new baits hit the market. These products have been tested and proven effective.

Residual Sprays - Introduction
These formulations are oil-based or water-based emulsions and water-based suspensions (wettable powders). They are available in ready-to-use pressurized containers or non-pressurized containers with built-in spray pumps. Residual sprays also can be purchased as concentrates to mix with water before applying with a compressed-air sprayer, plunger-type sprayer or paint brush.

Be careful when using oil-based insecticides; they may stain, dull or damage certain floor tiles, linoleum, painted surfaces, plaster, plastics, houseplants, carpets and carpet backing. Oil-based sprays can create a fire hazard when used near an open flame (pilot lights, gas stoves, furnaces). Water emulsions may stain wallpaper, light-colored carpets, draperies or other materials. They can short out electrical circuits, and are inferior to oil-based sprays on impervious surfaces such as glass or metal. Wettable powders must be frequently agitated in the spray tank, but they leave the most active residues, especially on porous surfaces such as unpainted wood, mortar or concrete block.

Residual sprays are generally easy and fast to apply. The spray should wet or dampen the treated surface; do not allow spray to puddle or run off. When treating for cockroaches, pay particular attention to cracks and crevices. Exposed surfaces, especially those used to prepare foods, should usually not be treated with sprays.

Dusts

Insecticide dust sometimes suffices as the only treatment for cockroaches, but is most often a supplemental treatment. Dusts generally have longer residual action than sprays, but are ineffective if they become damp. Dusts are useful in cockroach control because they can be placed deep in cracks, crevices and wall voids; under refrigerators and furniture; around pipes, tunnels and conduits; on very smooth or very rough surfaces; and in other places not treatable with other formulations. Do not use dusts for treating large surfaces because they leave unsightly deposits. Also, cockroaches avoid heavy deposits and will not walk through thick layers of the material. Use light pressure on the application device to minimize the amount of dust in living areas. Apply dusts as light, even residues that are barely visible.

Common active ingredients found in dust cockroach control products. This may not be a complete list and all products may not be available locally.[1]	
Active ingredient	*Examples of product names*
boric acid	Borid® Boric Acid Dust Enoz® Roach Away Hot Shot® MaxAttrax Roach Killing Powder Pic® Boric Acid Roach Killer III Roach Prufe®
diatomaceous earth/ silicon dioxide	Alpine® Dust Insecticide Cimexa™ Insecticide Dust Drione® (also contains pyrethrins) Mother Earth™ D Perma-Guard™ Household Insecticide D-20 (also contains pyrethrins) Safer® Ant and Crawling Insect Killer TriDie® Pressurized Silica + Pyrethrin Dust (also contains pyrethrin)
[1]Always read and follow directions on the product label carefully. Use only products that are labeled for in-home use.	

Baits - Detailed

Several cockroach baits are sold in ready-to use containers. They also can be made using a combination of food attractants and a toxicant. If cockroaches will not feed on the bait, the insecticide has no effect. Thus, it is important not to contaminate stored bait with organic solvents, other insecticides, fungicides and fertilizers. Baits are usually long lasting and often work well in areas that cannot be effectively sprayed or dusted. Baits are often most useful when used in conjunction with a residual spray or dust. Baits give best results in buildings where there are few alternative food supplies. Always use a sufficient number of bait containers to adequately treat an area where cockroaches are to be controlled. Examine the bait containers frequently to ensure they remain fresh and the bait is not depleted. Baits have always been available, but roaches seemed to be indifferent to them.

Although some roaches would feed and die, it was not likely that you would be able to control infestations with baits alone. Now, we have products like ***Maxforce*** and ***Avert***. These materials are deadly for roaches.

If you spray several properties or apartments and intend on doing a lot of baiting you should consider getting the ***Maxforce Bait Gun***. It uses the same ***Maxforce Gel*** in smaller cartridges which are loaded in the gun allowing for precise controlled applications and placements. They have been formulated with attractants which roaches cannot resist. You should be able to get complete control in homes, apartments and townhouses without having to do any spraying. The advantage of these products is that you are able to apply them with a minimum of preparation.

If you are careful, you should be able to apply Maxforce without having to remove anything from cabinets. Avert comes in an aerosol can which enables you to deliver the bait deep in wall voids where the roaches are hiding. The amazing thing about these products is that roaches love them to death.

There are videos of roaches crawling out of cabinets and wall voids in an attempt to get the bait! So attracted to these products are roaches that you only have to get them close to where the roaches are seen. They will find it. The drawbacks to these products are that they do take a little longer to work. It may take several days before you see dead roaches. Another disadvantage is that you must be careful not to spray the bait placements with traditional materials. They will contaminate the bait and roaches will simply ignore it.

In fact, roaches will ignore bait placements that have been made over treated surfaces, so make sure to apply ***Maxforce*** or ***Avert*** where you are certain no residual pesticide has been applied. In general, make your placements about 2 – 3 feet apart. In the average cabinet, you will need to make 6-8 placements with Maxforce. Since Maxforce comes out like toothpaste, it is difficult to penetrate voids with it. Use Avert for these hard to penetrate nest sites.

Avert is a different flavor than Maxforce and when the two are used together, you will get the quickest results**.** This is achieved because you are offering the insects a variety of food. By having two flavors available, the roaches are more likely to find one of the products. Since roaches will change their diet, having an option ensures they will find one if they don't' like the other.

Active ingredient (a.i.)	Brand name	Form	Availability
abamectin	Avert	gel, powder	Professionals only
boric acid	Niban	granules	Professionals only
	Stapleton's Magnetic Roach Food	paste	Blue Diamond tel. 800 237-5705 available to homeowners
fipronil	Maxforce	bait station, gel	Professionals only
hydramethylnon	Combat	bait station, gel	Homeowners
	Maxforce	bait station, gel	Professionals only
	Siege	gel	Professionals only
indoxacarb	HotShot Maxattrax Ultra Brand Nest Destroyer Roach Bait	pellets	Professionals only
imidacloprid	Pre-Empt Professional Cockroach Gel Bait	gel	Homeowners

Aerosols
Aerosol insecticides may or may not have residual activity. A non-residual spray alone may not provide a high degree of control, but when used with a residual spray or dust, a high degree of control can be achieved. Non-residual aerosols are useful for determining the location and extent of a cockroach infestation. Small amounts of pesticide applied to hidden areas and shelters force cockroaches to evacuate and move across previously treated surfaces. Residual aerosols should be used in the same manner as other types of residual sprays.

Inorganic insecticides
Boric acid and powders of silica aero gel and diatomaceous earth are examples of inorganic insecticides that can be used effectively for cockroach control in homes. These chemicals are low in toxicity to humans and pets, and retain their effectiveness long after initial application. Usually, a longer period of time is required to achieve control, but reapplications are greatly reduced.

Apply boric acid, silica aero gel or diatomaceous earth in a light film to cracks and crevices and other cockroach hiding places. Avoid applications to moist or damp areas, especially when using silica aero gel or diatomaceous earth. If cockroaches become established, chemical control may be needed in combination with good sanitary practices.

The following generic insecticides are registered for controlling cockroaches:

acephate (Orthene®)
allethrin
boric acid
permethrin
phenothrin
propoxur (Baygon®)

chlorpyrifos (Dursban®)	pyrethrins
cyfluthrin	resmethrin
diazinon	sulfluramid
malathion	tetramethrin

These insecticides are sold in different formulations and under various brand names. Basic formulations available are: aerosols, baits, dusts and liquid sprays. The insecticide products must be applied in a thorough manner to all areas where roaches are located. Application may be repeated for effective control.

Suggested insecticides and formulations for cockroach control.

INSIDE THE HOME*	BAITS	OUTSIDE AREAS
Allethrin AE	Boric Acid B	Carbaryl S
Bendiocarb D	Propoxor B	Chlorpyrifos S,G
Boric Acid D, AE	Sulfuramid B	Fenvalerate S, AE
Chlorpyrifos S, D, AE	Chlorpyrifos B	Malathion S
Cyfluthrin S	Hydramethlynon B	Permethrin, S
Diatomaceous Earth D		
Deltamethrin		
Dichlorvos AE		
Fenoxycarb AE		
Fenvalerate AE		
Hydroprene AE		
Malathion S		
Methoprene S, AE		
Permethrin S, AE, D		
Phenothrin AE		
Propoxur AE		
Resmethrin AE		
Sumithrin AE		
Synergized Pyrethrins S, AE		
Tetramethrin AE		

S = spray; AE = aerosol; D = dust; B = bait; G = granules
*Some products will have varying combinations of several active ingredients.

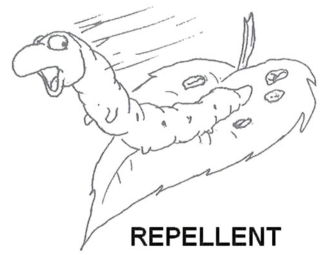
The reason they appear to be "***resistant***" in most cases is that they are simply avoiding treated areas. This can happen when products are mixed at higher rates or when applicators fall victim to treating the same areas over and over again. The roaches which survive all these applications are the ones which are going where the applicator has failed to treat.

Other Methods of Control

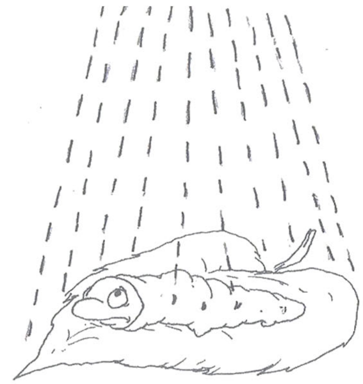
• Temperature: In some situations, temperature may be used to control cockroaches. High temperatures, for example above 125 degrees for two hours, will kill all cockroaches in an area. Of course, since cockroaches will move to a more desirable site it is important to do a whole area heat treatment. Consistently low temperatures will discourage cockroaches from establishing themselves.

• Electronic pest control devices: No electronic pest control device has been shown to be effective in controlling German cockroaches.

INGESTED

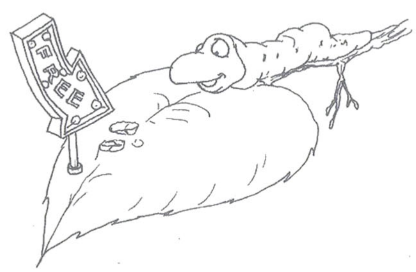


REPELLENT



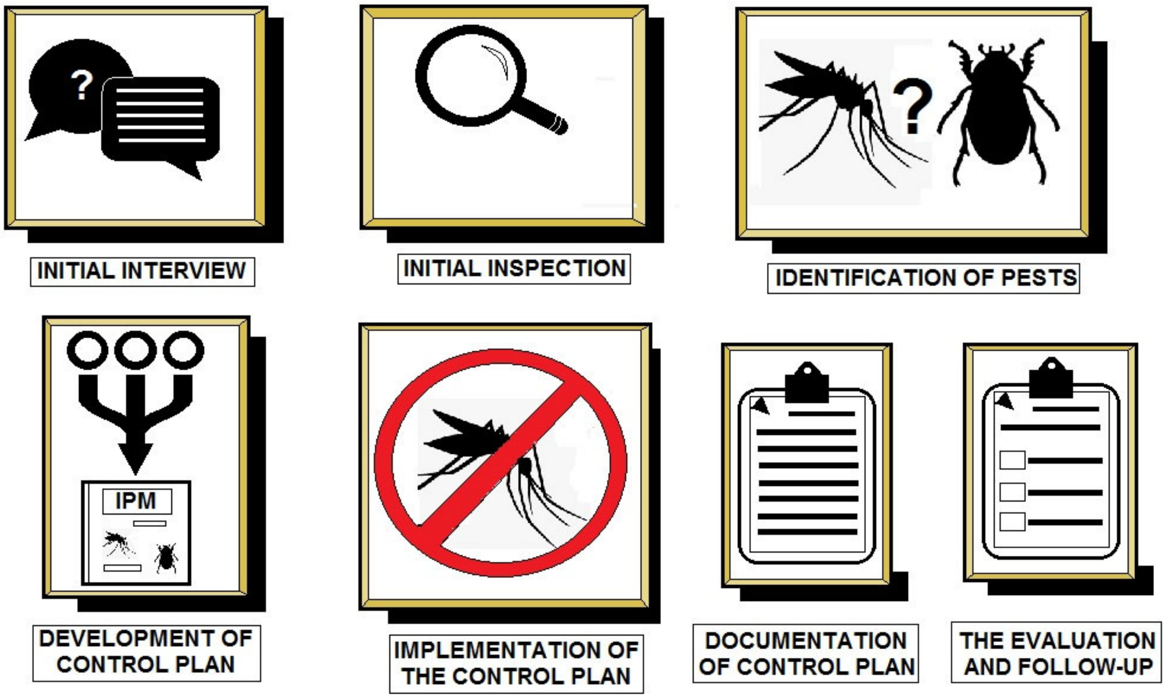
DIRECT CONTACT

SECONDARY CONTACT



LURE AND KILL

FUMIGANT



DEVELOPING AN INTEGRATED PESTICIDE MANAGEMENT PROGRAM (IPM)

Cockroach Control Home Remedies

I stopped going to a regular medical doctor and only see naturalpath doctors and many customers are the same with pesticides. Here are some remedial methods and techniques that serve as best roaches repellent, and can be tried at home. Try these effectual home remedies to get rid of roaches quickly and solve some problems, how to keep away roaches permanently.

1. Bay Leaves
Easily available in any grocery store and a common ingredient in kitchens, and a solution for those seemingly permanent roaches, bay leaves are surprisingly effective**.** Leave a bundle of them near sink holes, corners and crevices where roach nests are likely to be to fend off the pests. You can also place a packet of bay leaves in cupboards to protect books and clothes from the cockroaches.

2. Ammonia Solution
Cockroaches often hide in sinks and drain pipes. Ammonia is a top class house hold roaches home remedy in these situations. Add a cup full of ammonia in a bucket of water and flush it down sinks and toilets to clean out the pipes. The strong pungent smell will ward off the roaches nesting in pipes and sewers.

3. Moth Balls
Moth balls are excellent for warding off all kinds of pests including roaches. Place a few in your cupboard and near specific areas prone to infestation or likely to be the nesting area for roaches. However, they are not good for humans either so it is important to keep them away from children.

4. Mint Oil
Spray mint oil directly at the pests or in sinks and corners of your kitchen and bathrooms where roaches are more likely to settle. They may not work as fast as some other home remedies, but are a natural and nontoxic way of keeping your home roaches free over time.

5. Listerine
Listerine not only has antiseptic properties as a mouthwash but can also be used to disinfect your house. Dilute Listerine solution with some water and spray this mixture at nests or pests or around the kitchen and bathrooms to get rid of roaches.

6. Cedar
Cedar can be available in the form of balls, chips or blocks to ward off all kinds of pests including roaches. One of the best roach repellents, cedar is often used to line cupboards and closets to keep these troublesome pets away.

7. Petroleum Jelly Trap
If you are feeling particularly creative, line the rim of a jar with petroleum jelly and leave it overnight with some food in it as a trap. The roaches will climb in for the food but will be trapped in, unable to escape because of the petroleum.

8. Bleach
Bleach is one of the most common disinfectants used in the house. Mix it with water and pour it down sinks and toilets to keep your home clean and free from roaches living in drain pipes, sinks, and sewers. The bleach solution will drown away the troublesome roaches and their nests.

9. Lemon
Lemon has natural anti pathogenic properties. Add lemon juice to the water you use to mop your floors, kitchen tops and bathroom cabinets to keep germs away and repel roaches that cannot stand the citric smell.

10. Borax
Sprinkle borax near corners, crevices, sinks, and pipes in kitchens and bathrooms and leave it overnight. Being nocturnal creatures the roaches scurrying about at night will come in contact with the borax that dries out their exoskeletons and acts as a slow poison. Those affected by it will take it back to their nest effectively killing the other roaches too.

11. Soap Solution
Make a heavy soap solution in water and throw or spray it directly at the pests. Most of them will die instantly because soap clogs their pores making it impossible for them to breathe.

12. Pepper, Garlic and Onion solution
This potent mixture can be concocted by adding one tablespoon of pepper, a clove of garlic and half an onion mashed up together and added to a liter of water. Add some liquid soap if you want, and sprinkle this solution on kitchen and bathroom areas roaches frequent at night. You may also use this water to mop the floors or counter tops and cabinets. Roaches cannot stand the smell of this combination are likely to leave your home alone.

13. Cucumber
Leave some cucumber slices or peels overnight around kitchen counters and cabinets or near sinks and crevices where roaches may be especially active. Cucumbers are excellent roach repellents and are a nontoxic, organic way of getting rid of these pests. You may also use cucumber along with bay leaves to ward off pesky roaches.

14. Boric Acid and Cornstarch or Sugar
Use a mixture of sugar or cornstarch in addition with boric acid to kill harmful and persistent roaches. The sugar and cornstarch act as bait, attracting the roaches while the boric acid serves as poison for them, drying out their exoskeletons. This is a very effective method for getting rid of troublesome pests or a serious infestation. The only downside is the large number of dead cockroaches to clean next morning.

15. Coffee Trap
Fill the bottom of a jar with ground coffee to lure in the roaches that are attracted to the smell of caffeine. Fill the jar with water so that roaches drown in it, when they try to climb into the jar. The water clogs their pores and makes it impossible to breathe. Coffee trap is great home remedy to getting rid of cockroaches.

Fumigation Sub-Section

Tenting

Fumigation
Fumigation is a pest control method that fills an entire building with fumigants that will either poison or suffocate the pests inside. It is often the only way to get rid of termites and wood boring insects that are causing extensive damage to wooden areas in a home or factory. The building to be fumigated is first completely covered with large tarpaulins or ‘tents’. The fumigant is then released inside the building. The building will remain covered for a certain period of time. This allows the fumigant to penetrate all areas and kill the pests. After this, the building is ventilated so that the poison can disperse. It will then be safe for humans to re-enter the premises. The reason for the tarpaulins is to prevent the fumigant escaping and causing potential harm to neighboring people / buildings. The pest fumigation process can take up to a week to complete, depending on the level of infestation and the size of the building. Methyl bromide was the most commonly used fumigant until it was banned because it harms the ozone layer. Present day fumigants include phosphine, chloropicrin, hydrogen cyanide, methyl isocyanate, iodoform, and sulfuryl fluoride. A popular choice among many pest control services is sulfuryl fluoride. More on these fumigants in few minutes.

Tenting
Structural fumigating techniques differ from building to building, but in houses a rubber tent is often placed over the entire house while the pesticides are being released into the vacant residence. This process is called tent fumigation or "tenting". The sealed tent concentrates the poisonous gases and prevents them from escaping into the neighborhood. The process can take up to a week depending on the fumigant used, which in turn depend on the severity of infestation and size of the building. Fumigation is a very hazardous operation.

Generally speaking, it is a legal requirement that the operator, carrying out the fumigation operation, holds official certification to perform the fumigation as the chemicals used are toxic to most forms of life, including humans.

Post Operation Ventilation
Post operation ventilation of the area is a critical safety aspect of fumigation. It is important to distinguish between the pack or source of the fumigant gas and the environment which has been fumigated. While the fumigant pack may be safe and spent, the space will still hold the fumigant gas until it has been ventilated.

Fumigation Application
Application means introducing the solid, liquid or gas fumigant product into an empty space, an area containing a commodity, or a rodent burrow. In most cases with space fumigations, the fumigant is applied from outside without actually entering the structure. Application methods differ depending upon (i) the fumigant formulation being used, (ii) site/area being treated and (iii) the target pest. For example, fumigation of infested grain using a solid fumigant product may involve pellets or tablets walked into the surface of the grain, applying pellets down into the grain mass with a probe, or the use of an automatic dispenser which uniformly applies the fumigant throughout the grain mass as the bin or silo is filled. When liquid phosphine (liquefied gas or liquefied gas under pressure) is used as a fumigant, it is introduced into the treated site with approved tubing where it disperses as a gas for quick distribution throughout the fumigated area. Outdoor rodent burrows are fumigated by placing pellets or tablets into the burrow and lightly sealing the entrance/exit.

Structure
“Structure” means any building regardless of its design or the type of material used in its construction, whether public or private, vacant or occupied the foundation thereof, and the adjacent enclosed areas. It shall also include but shall not be limited to warehouses, trucks, boxcars, railcars, ship holds, boxes, tarp covered stacks, other vehicles, or the contents thereof, and fumigation vaults.

Adjacent Enclosed Area
A space that is located next to or near a structure that is being fumigated and has the potential for the phosphine gas to enter into and accumulate or remain in this area. If people or domestic animals may enter into this area during the fumigation or aeration process, you are required to conduct monitoring to be sure no one is exposed above the permitted level of 0.3 ppm on an 8-hour time weighted average.

Fumigation Management Plan
A Fumigation Management Plan (FMP) is a written description of the steps designed to plan for a safe, legal and effective fumigation. It is important to note that some plans will be more comprehensive than others. The certified applicator and owner of the property to be fumigated must address characterization of the structure and/or area and include all safety requirements in the plan prior to application. A new FMP is not needed for every fumigation of an individual facility if conditions will not vary other than general updates such as temperature and humidity recordings. The FMP and related documentation, including monitoring records, must be maintained for a minimum of 2 years.

Although the Federal labeling allows trained workers to do certain activities associated with fumigations, some states may be more restrictive than others and require that a certified applicator always be physically present on site. Therefore, before proceeding with a fumigation, the client and/or certified applicator should consult with the State lead pesticide regulatory agency to determine regulatory status, requirements, and restrictions for use of fumigants in that state.

Most fumigation activities are carried out by a certified applicator or by a trained worker under the direct supervision of a certified applicator. As mentioned above, state restrictions and requirements vary. In some states certain specific activities can be turned over to a trained worker to complete the fumigation independently in the absence of a certified applicator. The CA may remain in voice contact if needed but not physically present.

These Specific Activities Include:

- ✓ Monitoring the fumigation site for gas leaks and accumulation of phosphine gas above the permitted limit
- ✓ completing the aeration of a structure after the aeration has progressed and stabilized
- ✓ removal of placards after the aeration is completed • receiving, aerating and releasing the content of a vehicle fumigated in-transit (Note: transporting vehicles under fumigation over public roads is prohibited)
- ✓ transfer of an unaerated commodity from one in-transit container to another storage site to continue with the fumigation disposal of any spent fumigant
- ✓ maintenance of written records of all permitted actions performed.

Monitoring for Safety

Monitoring for safety is always required unless it can be confirmed/concluded by the certified applicator that there is no possibility of exposure to phosphine at or above the allowable limits to workers or bystanders. Monitoring must be done if there is even the slightest possibility of exposure. Exposures to phosphine must not exceed the 8-hour Time Weighted Average of 0.3 ppm or the 15-minute Short-Term Exposure Limit (STEL) of 1.0 ppm.

Under Direct Supervision

When a fumigation product is being applied it must be under the supervision of a certified applicator. In many states “Under direct supervision” means the act or process whereby application of a pesticide is made by a competent person acting under the instructions and control of a licensee or certified applicator who is responsible for the action of that person and who is available if and when needed, even though such licensee or certified applicator is not physically present at the time and place the pesticide is applied. However, in some states certain activities as noted previously may not be performed without the physical presence of the CA.

Voice Contact

Voice contact means that the certified applicator (CA) is supervising the trained worker(s) by maintaining a voice communication, with or without being physically present on site. Voice contact when the certified applicator is present on-site may be accomplished by the use of phones or walkie-talkies in a situation where the CA and the trained worker are not working at a visible distance to each other (ex. when working at a large facility where several sheds or bins will be fumigated at the same time or while trouble shooting a gas leak after the fumigation has started). When both parties are not physically present on site, voice contact may be accomplished through the use of phones or walkie-talkies.

Safe Disposal

Fumigation starts with the introduction of the fumigant into a space or commodity that has been properly placarded and secured. It ends when aeration has rendered the space or commodity at or below established safe limits specified in the product labeling.

Safe disposal of the spent fumigant, according to label directions, must also be conducted following completion of the fumigation.

Fumigation Safety Rules

Phosphine fumigants are valuable tools as long as they are used properly. Read and follow all instructions on the label, including the applicator's manual to ensure a safe and effective fumigation. Store all containers of fumigant under lock and key, and keep a careful inventory so each container and package is accounted for. If you discover that any fumigant has been stolen, you are required to report the theft immediately to your local law enforcement authorities. Make sure the storage area is properly placarded as a pesticide storage area.

The applicator's manual specifies what must be on the placards for an area where phosphine fumigants will be stored. Never store fumigants inside a home or in any structure where humans or animals live. Just-in-time delivery of exactly the right amount of fumigant is the safest practice.

If you have to transport fumigants, keep the container(s) locked in a metal box in your truck bed. If you transport large quantities on a regular basis, you may want to consider a security system. The applicator's manual lists the hazards associated with transporting aluminum phosphide. Be aware of these hazards and have a list of them with you in the truck. Your truck will need to display a placard providing information about aluminum phosphide. If you are carrying less than 46 pounds of fumigant, you may be eligible for a placarding exemption, such as exemption DOT E 11329 (http://hazmat.dot.gov).

Important Reminders

All fumigants are dangerous, and their use requires specific training. All fumigants are restricted-use pesticides for application by trained and certified pesticide applicators only. This publication is intended to assist applicators who meet these requirements. It is always advisable, however, to consider using the services of a professional commercial fumigator to reduce both risk and liability.

Use fumigants according to the directions on the label.

Follow all directions, precautions, and restrictions that are listed. Do not use fumigants on commodities or sites that are not listed on the label. The fumigant rates listed in this publication are recommended only for those fumigants registered with the Environmental Protection Agency and the pertinent state department of agriculture. If the label is cancelled or changed, the information contained herein is no longer recommended.

Respiratory Protection

For personal protection against the vapors of phosphine at concentrations above the threshold limit, a respirator or other similar equipment for supplying uncontaminated air must be used. Respirators with a special canister for phosphine vapors will give protection up to 0.5 percent phosphine by volume in air (Kloos et al, 1966). Above this concentration, air must be supplied by an air-line or self-contained breathing equipment. Appropriate detection equipment for measuring concentrations of phosphine in air should be used in conjunction with respiratory protective devices to ensure adequate protection.

Pesticide First Aid

Symptoms of Poisoning

According to the amount of phosphine inhaled, symptoms may occur immediately or several hours after exposure. Slight or mild poisoning may give a feeling of fatigue, ringing in the ears, nausea, pressure in the chest and uneasiness. All of these symptoms will normally disappear in fresh air. Greater quantities will quickly lead to general fatigue, nausea, gastrointestinal symptoms with vomiting, stomach ache, diarrhea, disturbance of equilibrium, strong pains in the chest and dyspnea (difficulty in breathing).

Very high concentrations rapidly result in strong dyspnea, cyanosis (bluish-purple skin color), agitation, ataxia (difficulty in walking or reaching), anoxia (subnormal blood oxygen content), unconsciousness and death. Death can be immediate or occur several days later due to edema and collapse of the lungs, paralysis of the respiratory system or edema of the brain. Disturbances of kidney and liver functions (hoematuria, proteinuria, uremia, jaundice) and cardiac arrhythmia may occur.

Advice to the Physician

The following measures are suggested by the manufacturer for use by the physician in accordance with his own judgment.

In its milder forms, symptoms of poisoning may take some time (up to 24 hours) to make their appearance, and the following measures are suggested:

1. Complete rest for one or two days, during which the patient is kept quiet and warm.
2. Should the patient suffer from vomiting or increased blood sugar; appropriate intravenous solutions should be administered. Treatment with oxygen breathing equipment is recommended as is the administration of cardiac and circulatory stimulants.

In cases of severe poisoning intensive care in a hospital is recommended:

1. Where pulmonary edema is observed, steroid therapy should be considered and close medical supervision is recommended. Blood transfusions may be necessary.
2. In case of manifest pulmonary edema, venesection should be performed under vein pressure control, and intravenous administration of glycosides (in case of haemoconcentration, venesection may result in shock). On progressive edema of the lungs, perform immediate incubation with constant removal of edema fluid and establishment of oxygen positive pressure respiration, as well as any measures required for shock treatment. In Case of kidney failure, extracorporeal hemodialysis is necessary. There is no specific antidote known for this poison.
3. Suicide may be attempted by taking solid phosphides by mouth. In such a case, empty the stomach by inducing vomiting and flush it with a dilute potassium permanganate solution or a solution of magnesium peroxide until the flushing liquid ceases to smell of carbide. Thereafter, administer medicinal charcoal.
4. Scientific research has shown that phosphine poisoning is not chronic; the action of phosphine is reversible and symptoms will disappear by themselves.

Health Effects & Toxicity

Fumigant pesticides also are among the most toxic chemicals used in agriculture. The U.S. EPA categorizes most fumigants as "highly acutely toxic"-- the agency's most extreme toxicity category.

Acute Fumigant Poisoning

Acute fumigant poisoning causes eye irritation, sore throat, headaches, nausea, vomiting, breathing difficulties and aggravated asthma, and neurological effects such as convulsions, dizziness, or tremors.

Fumigant exposure also has long-lasting effects that include, many applicators will die from these…

Cancer

Several fumigants are known carcinogens, including methyl iodide, 1,3-Dichloropropene, and metam sodium; all of which are included in California's Proposition 65 carcinogen list.

Respiratory Damage

Exposure to fumigants can cause permanent respiratory damage. In lab animals chronically exposed to chloropicrin, researchers observed permanent damage to the bronchial tree, as well as lung cancer and tumors. The CDC classifies chloropicrin as a "lung damaging agent," noting that poisoning can cause a lethal pulmonary edema.

Neurological Effects

Methyl bromide and methyl iodide are both potent neurotoxins. Exposure to methyl bromide adversely affects cognitive function, physical coordination and muscular control (Extension Toxicology Network).

- Reproductive & developmental effects: Some fumigants are linked to elevated risk of miscarriage. In animal studies, fetal survival rate was significantly reduced from methyl iodide exposure.
- Immune system effects: Research shows that exposure to metam sodium and its breakdown product, methyl isothiocyanate, can weaken the human immune system.
- Endocrine Disruption: Fumigants are known to interfere hormones. In laboratory studies the fumigant metam sodium suppressed hormones that control ovulation and also increased stress hormones. Methyl iodide disrupts thyroid hormones critical for fetal development, resulting in increased miscarriage and developmental delays research shows.

Poisonings & Drift

The volatility of fumigants makes them inherently dangerous. Communities and farmworkers near agricultural fields face serious risks of acute pesticide poisoning from drifting fumigants. Fumigant drift has also been measured in air far from application sites, sometimes at levels above those considered “acceptable” for longer-term seasonal exposures by EPA or the California Department of Pesticide Regulation. Results from PANNA's Drift Catcher project in Sisquic, California showed that residents were exposed to levels of chloropicrin that exceeded California's acute level of concern for children.

Every few years there is a mass fumigant poisoning:

- In November 1999, drifting metam sodium poisoned an entire neighborhood in Earlmart, California, resulting in the evacuation of 150 people from their homes. One Earlimart resident recalled that she first noticed something was wrong when her infant son’s eyes began to tear.
- In October 2003, a plume of chloropicrin drifted into the California community of Lamont after being applied to a nearby onion field. 150 residents were poisoned. Despite the widespread illness, application of the pesticide was continued the next day and 100 more people were affected.

Fumigants Detailed

Phosphine

Phosphine (IUPAC name: phosphane) is the compound with the chemical formula PH3. It is a colorless, flammable, toxic gas. Pure phosphine is odorless, but technical grade samples have a highly unpleasant odor like garlic or rotting fish, due to the presence of substituted phosphine and diphosphine (P_2H_4). With traces of P_2H_4 present, PH_3 is spontaneously flammable in air, burning with a luminous flame. Phosphines are also a group of organophosphorus compounds with the formula R_3P (R = organic derivative). Organophosphines are important in catalysts where they complex to various metal ions; complexes derived from a chiral phosphine can catalyze reactions to give chiral products.

Forms

Phosphine fumigants are sold in solid form, either as aluminum phosphide or magnesium phosphide. This publication focuses on aluminum phosphide that is sold under various brand names including Phostoxin, Phosfume, and Weevilcide. Aluminum phosphide can be used to eliminate insect infestations in a variety of commodities, including animal feed and feed ingredients, corn, cottonseed, grass seed, millet, oats, peanuts, pecans, popcorn, rye, sorghum, soybeans, triticale, and wheat. They can also be used for a variety of processed foods as long as the residue dust does not come in direct contact with the product. They can be used on some nonfood commodities including straw and hay, cotton, feathers, tobacco, dried plants and flowers, and seeds. The fumigant label contains a complete list of commodities that can be fumigated. Phosphine fumigants can be used in a variety of structures including grain bins and silos, rail cars, warehouses, and flat storage structures.

Aluminum phosphide is packaged as tablets about 5/8 inch in diameter, as pellets about 3/8 inch in diameter, or as granules in a sachet or small, porous bag. Tablets release about five times more phosphine gas than pellets release. At high temperatures, it may be safer to use tablets because they break down slower than pellets. If you are fumigating a raw agricultural commodity, you can use tablets or pellets, without removing the residue. For processed commodities, prepacs, ropes, or blankets, keep the residue within the packaging so it can be removed after the fumigation. Pest fumigation is a dangerous operation. It must be carried out by competent personnel or registered pest control companies that are in possession of the correct certification that allows them to perform pest fumigation operations.

Monitoring Done

There are a number of devices on the market for the measurement of phosphine gas. The devices range from glass tubes to electronic equipment. Knowledge of the use and limitations of such devices are part of the training program for fumigation workers. Registrants of phosphine products also serve as an additional source for information on these devices.

Make sure all employees know about the fumigation and are aware of potential safety hazards and emergency procedures. Make a list of the telephone numbers and addresses of the nearest fire department, rescue squad, hospital emergency room, and police department, and notify each agency of the fumigation ahead of time. Include on the list the names and telephone numbers of all appropriate personnel in charge. Provide each agency with a copy of your fumigation management plan and any other information needed in case of an emergency.

This information should include the Material Safety Data Sheet (MSDS) for the phosphine fumigant used and a copy of the label, including the applicator's manual. There may be local requirements in addition to those in the applicator's manual and label. As you work your way through notifying the above agencies, you may learn of additional requirements.

Accidents involving aluminum phosphide are rare — but in case the worst happens, a well-informed emergency response team would have a greater chance of saving your life than one that has not been informed about the hazards of aluminum phosphide.

A certified applicator is someone who has passed a state exam. Individuals receiving specific instructions in documented training sessions are classified as trained applicators. One certified applicator and another trained person are the minimum personnel required when aluminum phosphide is applied. Two trained people can legally make the application, as long as they are under the direct supervision of the certified applicator. All should carry some form of communication device, such as a radio, a walkie-talkie, or a cellular phone. See the applicator's manual for requirements after the application.

You cannot follow label instructions without knowledge of the phosphine gas concentration during the fumigation process. One possible exception would be an isolated farm bin location on private property. The label requires that you keep a log showing phosphine gas concentration at key locations surrounding the structure. The type of respiratory equipment used depends on the gas concentration. Furthermore, it makes sense to monitor the gas inside the structure (using extension hose from a safe outside location) to make sure an insect-lethal concentration of gas is present

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used.

Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them.
If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

Chloropicrin
Some trade names for products containing chloropicrin include "Chlor-O-Pic," "Metapicrin" "Timberfume" and "Tri-Clor." A partial list of trade names for chloropicrin mixtures with methyl bromide includes "Tri-Con," "Terr-O-Gas," "Preplant Soil Fumigant" and "Pic-Brom." Chloropicrin mixtures with 1,3-Dichloropropene include "Telone C-17," "Tri-Form" and "Pic-Clor."

Regulatory Status
Chloropicrin is currently undergoing USEPA FIFRA reregistration. It is a Class I toxicity, Restricted Use Pesticide (RUP), labeled with the signal word "Danger". The U.S. Department of Transportation (DOT) proper shipping name is "Chloropicrin, 6.1, UN 1580, PGI, Poison Inhalation Hazard, Hazard Zone B." The Emergency Response Guide (ERG) number is 56. NFPA designations are 4-Health, 0-Fire, 3-Reactivity. Chloropicrin is not listed under the EPA Clean Air Act, EPA Clean Water Act or the EPA Marine Pollutant List. A tolerance is not required for pre-plant soil fumigation uses of chloropicrin.

Description
Chloropicrin is a clear, colorless, oily liquid with a strong, sharp, highly irritating odor. It is a strong lachrymator. Chloropicrin has been used as an insecticide since 1917 and as a soil fumigant since 1920. The primary use today is for preplant soil fumigation to control soil borne fungi, diseases and nematodes. It also is used to treat wood poles and timbers for internal decay by fungi and insects; as a warning/clearing agent for sulfuryl fluoride (structural fumigant) and methyl bromide (soil and structural fumigant); and is also used in organic synthesis.

For soil fumigation and wood treatment, chloropicrin is packaged in DOT 4BW240 steel cylinders and bulk tanks which may be pressurized. When used as a warning agent for methyl bromide, chloropicrin is packaged along with the methyl bromide in steel cylinders. When used as a structural fumigation warning agent for sulfuryl fluoride, chloropicrin is packaged in small plastic bottles in DOT approved overpacks.

Chloropicrin has a moderate vapor pressure (18.3 mmHg at 20 degrees C) and exists as a liquid at room temperature. Chloropicrin/methyl bromide mixtures will volatilize readily upon opening of the cylinder valve. Materials incompatible with chloropicrin are PVC, fiberglass, aluminum and magnesium and their alloys. Pest fumigation is a dangerous operation. It must be carried out by competent personnel or registered pest control companies that are in possession of the correct certification that allows them to perform pest fumigation operations.

Soil Fumigation
Chloropicrin is injected as a liquid into the soil approximately 6-10 inches below the surface, 14 days or more before crop planting. It kills target fungi within 48 hours of application. Chloropicrin also controls some root-destroying nematodes, soil insects, and other plant-limiting pests. The importance of soil fumigation in the control of plant pathogens cannot be overstated. Even in agricultural soil with adequate nutrients, water and oxygen, plant growth and crop yields can decline over time due to increasing levels of pathogenic fungi and other pests. In the 1950s, before soil fumigation with chloropicrin, California strawberry growers resorted to applying 500 pounds/acre or more of nitrogen because of plummeting crop yields. The problem was not lack of soil nutrients--it was lack of healthy roots. Strawberry root diseases were widespread at the time and the partially rotted roots were not capable of absorbing the abundant nitrogen that was available. By making high crop yields predictable and at the same time reducing the use of fertilizers, chloropicrin/MeBr combinations have made it possible to replant the same fruit and vegetable land year after year. Predictable crop yields have allowed breeders to concentrate their efforts on fruit quality, appearance, and shipability.

Environmentally, chloropicrin does not have a significant ozone depletion potential because it undergoes rapid breakdown in sunlight. It is metabolized in soil to carbon dioxide. Under anaerobic/aquatic conditions, chloropicrin is converted to nitromethane within hours. In a plant metabolism study utilizing soil treated with radiolabelled chloropicrin, no chloropicrin or nitromethane was detected in any plant tissue or harvested produce.

How is chloropicrin used?
Extremely small quantities are used as part of the fumigation process, at concentrations that provide adequate warning without causing lingering odors or other adverse effects for home owners or the environment.

How is chloropicrin released into a home?
The fumigator carefully measures and pours the chloropicrin onto an absorbent material in one or more shallow pans. The pans are then placed near fans in the area where Vikane will be released. Air movement from the fans helps evaporate the chloropicrin and distribute it throughout the structure. Chloropicrin is released at least five to ten minutes before introducing Vikane to make sure is has sufficient time to act as a warning agent within the structure.

You as the fumigator shall conduct a walk-through inspection to help confirm everyone is out of the structure prior to releasing chloropicrin. You as the fumigator shall also post warning signs around the structure to help prevent early or accidental re-entry. In addition, you as the fumigator shall use secondary locks on the entrances of your home that requires a special key to gain access to help ensure the structure remains free of people throughout the fumigation process.

Is the amount of chloropicrin used during the fumigation harmful to people?
Should I be concerned about it affecting my health? According to the product label, chloropicrin is used at very low application rate of 1 fluid ounce for every 10,000 to 15,000 cubic feet of fumigation space.

This results in a controlled concentration of chloropicrin within the structure during the fumigation. After the fumigation period, your fumigator will aerate the Vikane and chloropicrin down to DPR accepted levels acceptable for you to re-enter the home. Once clearance has taken place, the amount of chloropicrin remaining in the home is at such a low level that homeowners need not to be concerned with any toxicological effects.

What should I do if I sense chloropicrin or experience symptoms after the fumigation?
Minute amounts of chloropicrin remaining in the structure may cause tearing, a scratchy throat or coughing. Although every effort is made to clear chloropicrin from you home, it may still be detectable at extremely low concentrations. Even if you sense chloropicrin immediately following the fumigation of your home, a small amount of chloropicrin does not mean Vikane is still present.

Vikane aerates from structures more rapidly, and fumigators use sensitive detection equipment to ensure that Vikane is cleared from you home prior to allowing re-occupancy. A few simple steps can assist in clearing any remaining chloropicrin from a home. A small amount of chloropicrin does not mean Vikane is present. It is recommended that you as the fumigator shall complete the next steps: Retest to confirm is cleared from your home. Open windows. Operate fans of air-handling systems such as heat or air conditioning. Place additional fans near windows to create a directed air flow through the structure for efficient aeration. Increase the temperature within the structure by turning off the air cooling compressors of air conditioners in the warmer months (operating the fan only) and using the central heating system in the cooler months. The above steps may require a few hours for the fumigator to complete. Leave the structure during this time if you continue to experience irritation from chloropicrin.

Hydrogen Cyanide (HCN)

Hydrogen cyanide is one of the most toxic of insect fumigants, many applicators and customers alike have died from this chemical. I know of one applicator that went to prison for not following the label instructions. I know another person whose son died from the effects of a poor treatment/ventilation method. The fact that Hydrogen cyanide is very soluble in water has considerable bearing on its use in practice. Thus, it may produce injury on moist materials, such as fruit and vegetables, because the solution of HCN in water is a dilute acid. Not only does this acid render these materials unpalatable and possibly hazardous for human consumption, but its action, by causing burning, wilting or discoloration, may make them unmarketable.

On the other hand, HCN has been widely used for fumigating dormant nursery stock that is sufficiently dry. It may be used for some living plants if they can be washed with water immediately after treatment to prevent burning by the acid.

HCN may be employed for fumigating many dry foodstuffs, grains and seeds. Although HCN is strongly sorbed by many materials, this action is usually reversible when they are dry, and, given time, all the fumigant vapors are desorbed. With many foodstuffs little, if any, chemical reaction occurs, and there is no detectable permanent residue. Because of the high degree of sorption at atmospheric pressure, HCN does not penetrate well into some materials. It WAS largely because of this that vacuum fumigation was adopted. Pest fumigation is a dangerous operation. It must be carried out by competent personnel or registered pest control companies that are in possession of the correct certification that allows them to perform pest fumigation operations.

Toxic

HCN is a powerful, quick acting poison. In humans and other warm-blooded animals, it induces asphyxiation by inhibiting the respiratory enzymes and renders tissues unable to absorb oxygen from the blood in the normal manner.

The toxic action is reversible. In practice, this means that a person who is completely unconscious from the effects of cyanide, but whose heart is still beating, may still recover if suitable antidotes nod remedial measures are applied in time. HCN may be absorbed in toxic amounts through the unbroken skin (see below under "Precautions").

Toxicity to Insects

Among the commonly used fumigants, HCN is one of the most toxic to insects. It also has a rapid paralyzing effect on most species. This action is an important consideration in dealing with insects, because sub-lethal concentrations may bring about apparent death. After exposure to the fumigant, the reversible action of the poison may permit the insect to recover.

This reaction has already been referred to as protective stupefaction (Lindgren, 1938). It is important from the practical point of view because it means that the maximum recommended concentration should be attained as quickly as possible during the application of the fumigant.

Flammability Limits

The flammability limits of HCN in air lie between 6 and 41 percent by volume. These limits are well above the normally recommended fumigation doses of up to 1.5 percent (16 g/m^3 or 16 oz/l 000 ft^3). However, it must be pointed out that, at the point of release of the gas at the beginning of a fumigation, a concentration within these limits may exist for a short length of time. If there is any flame (such as a pilot light) or sparks near temporary high concentrations, a serious fire or explosion could occur. In working with this fumigant, great care must be exercised to extinguish all flames and turn of all electric switches before a treatment begins.

Precautions
Respirators
Respirators fitted with the canister for acid gases will give protection against HCN and must be worn during all operations in which there is exposure to any concentration of this gas.

Absorption through Human Skin
HCN may be absorbed in toxic amounts through the unbroken skin; the amount is increased if the skin is moist. With modern fumigation techniques it is unnecessary for an operator to remain in a full fumigation concentration of HCN. The fumigant is either discharged from cylinders outside the structure or the gas is generated indoors by one of the methods described above. In the second type of operation, workers who apply granular calcium cyanide or HCN discs, or who initiate generation by dropping sodium cyanide into acid, are able to move away before a heavy concentration of fumigant builds up. During the aeration process it is usually possible to open some doors and windows from outside the structure and to start exhaust fans and blowers so that the full concentration of HCN in the air may be reduced before any person goes inside.

Although the industrial-type respirator canister will remove concentrations of HCN in air up to 2 percent by volume for a limited length of time, it is recommended, in order to avoid absorption of dangerous amounts through the skin, that persons wearing respirators do not remain for more than 5 minutes in concentrations of 0.75 percent or for more than 20 minutes in concentrations of 0.5 percent.

Symptoms of HCN Poisoning
Unless a person is immediately overcome by an overpowering concentration of HCN, a situation unlikely to be encountered in fumigation work when proper precautions are taken, there are preliminary symptoms which serve as a warning of poisoning. These symptoms are common to poisoning caused both by breathing HCN or by its absorption through the skin.

More common warning symptoms of HCN Poisoning are:
- irritation of the mucous membrane of the eyes, throat and upper respiratory tract;
- burning sensation on the tongue;
- metallic taste in the mouth
- feeling of pressure in the forehead;
- sharp pains in the head;
- giddiness and disturbed equilibrium;
- nausea and vomiting

If any of the foregoing, or related symptoms are experienced while a person is in the presence of HCN in any concentration, he should move immediately into fresh air, preferably where it is warm, and, if necessary, undergo the first aid treatment outlined below.

Although the poisonous action of HCN is rapid, a person may live for several hours after being completely overcome (Chen et al, 1935). Thus, even if there is some delay in the application of remedial treatments by the physician, it may still be possible to bring about the recovery of the patient.

This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

Methyl Iodide

Methyl iodide is the proposed replacement for methyl bromide, is in fact more toxic than its predecessor. Pest fumigation is a dangerous operation. It must be carried out by competent personnel or registered pest control companies that are in possession of the correct certification that allows them to perform pest fumigation operations.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

Methyl Isocyanate (MIC)

Methyl isocyanate is an organic compound with the molecular formula C2H3NO, arranged as H3C-N=C=O. Synonyms are isocyanatomethane, methyl carbylamine, and MIC. Methyl isocyanate is an intermediate chemical in the production of carbamate pesticides (such as carbaryl, carbofuran, methomyl, and aldicarb). It has also been used in the production of rubbers and adhesives. As a highly toxic and irritating material, it is hazardous to human health, and was involved in the Bhopal disaster which killed nearly 8,000 people initially and approximately 17,000 people in total. Methyl isocyanate is an intermediate chemical in the production of carbamate pesticides (such as carbaryl, carbofuran, methomyl, and aldicarb). It has also been used in the production of rubbers and adhesives.

Methyl isocyanate (MIC) is extremely toxic. The threshold limit value set by the American Conference on Government Industrial Hygienist was 0.02 ppm. MIC can damage by inhalation, ingestion and contact in quantities as low as 0.4 ppm. Damage includes coughing, chest pain, dyspnea, and asthma, irritation of the eyes, nose and throat, as well as skin damage.

Higher levels of exposure, over 21 ppm, can result in pulmonary or lung edema, emphysema and hemorrhages, bronchial pneumonia and death. Although the odor of methyl isocyanate cannot be detected at 5 ppm by most people, its potent lachrymal properties provide an excellent warning of its presence (at a concentration of 2–4 parts per million (ppm) subject's eyes are irritated, while at 21 ppm, subjects could not tolerate the presence of methyl isocyanate in air).

Proper care must be taken to store methyl isocyanate because of its ease of exothermically polymerizing (see Reactions) and its similar sensitivity to water. Only stainless steel or glass containers may be safely used; the MIC must be stored at temperatures below 40 °C (104 °F) and preferably at 4 °C (39 °F).

The toxic effect of the compound was apparent in the Bhopal disaster, when around 42,000 kilograms (93,000 lb.) of methyl isocyanate and other gases were released from the underground reservoirs of Union Carbide India Limited (UCIL) factory, over a populated area on December 3, 1984, immediately killing thousands and leading to the deaths of tens of thousands in subsequent weeks and months.

Iodoform

Iodoform is the organoiodine compound with the formula CHI3. A pale yellow, crystalline, volatile substance, it has a penetrating odor (in older chemistry texts, the smell is sometimes referred to as the smell of hospitals) and, analogous to chloroform, sweetish taste. It is occasionally used as a disinfectant. It is sometimes also referred to as carbon triiodide (which is not strictly correct, as this compound also contains hydrogen) or methyl triiodide (which is somewhat ambiguous as that name could also refer to the methylated triiodide ion, CH_3I_3. Pest fumigation is a dangerous operation. It must be carried out by competent personnel or registered pest control companies that are in possession of the correct certification that allows them to perform pest fumigation operations.

The compound finds small scale use as a disinfectant. Around the beginning of the 20th century it was used in medicine as a healing and antiseptic dressing for wounds and sores, although this use is now superseded by superior antiseptics. Adolf Hitler's mother, Klara Hitler, died of iodoform poisoning brought on by her treatment for breast cancer. It is the active ingredient in many ear powders for dogs and cats, to prevent infection and facilitate removal of ear hair, along with zinc oxide and propanoic acid.

Formaldehyde

Formaldehyde is an organic compound with the formula CH2O. It is the simplest aldehyde, hence its systematic name methanal. Formaldehyde is a colorless gas with a characteristic pungent odor. It is an important precursor to many other chemical compounds, especially for polymers. In 2005, annual world production of formaldehyde was estimated to be 23 million tons (50 billion pounds). Commercial solutions of formaldehyde in water, commonly called formalin, were formerly used as disinfectants and for preservation of biological specimens. In view of its widespread use, toxicity and volatility, exposure to formaldehyde is a significant consideration for human health. On 10 June 2011, the US National Toxicology Program has described formaldehyde as "known to be a human carcinogen".

American Cockroaches Invincible

American" adult cockroaches can survive exposure to various forms of fumigation, including formaldehyde fumigation that is carried out at double strength and for four times as long as is recommended for disinfection of rooms. It is further reported that vaccinia virus ingested prior to the fumigation survives in the cockroach gut and may be excreted up to 5 days later. Since cockroaches are ubiquitous and are to be found in most hospitals, laboratories and animal houses, these findings should be considered whenever fumigation is called for.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator’s legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

Sulfuryl Fluoride

Sulfuryl fluoride has the ability to kill pests at any stage of their lives, including eggs. It does not harm the ozone layer and it is not associated with the dangers of phosphine. Sulfuryl fluoride is used widely as a pest fumigant to control dry wood termites that thrive in warm climates. It is also effective for the eradication of bark beetles, powder post beetles, rodents and bed bugs. Sulfuryl fluoride is the inorganic compound with the formula SO_2F_2. This easily condensed gas has properties more similar to sulfur hexafluoride than sulfuryl chloride, being resistant to hydrolysis even up to 150 °C. So inert is this material that suspended molten "sodium metal retains its shiny metallic appearance." Use of SO_2F_2 as a fumigant has increased rapidly as it replaces methyl bromide, now being phased out because of harm to the ozone layer, and as an alternative to the risks of phosphine.

Originally developed by the Dow Chemical Company, sulfuryl fluoride is in widespread use as a structural fumigant insecticide to control drywood termites, particularly in warm-weather portions of the southwestern and southeastern United States and in Hawaii. Less commonly, it can also be used to control rodents, powderpost beetles, bark beetles, and bedbugs.

Sulfuryl fluoride is currently marketed by three distinct manufacturers, under four different brand names. Vikane (Dow) (EPA Reg. No. 62719- 4-ZA) has been commercially available since the early 1960s, with Zythor (marketed by competitor Ensystex of North Carolina) (EPA Reg. No. 81824- 1-AA) being more recently introduced gradually as its use is approved by individual states (in Florida circa 2004, but not in California until October 2006, for example).

Dow recently has begun marketing sulfuryl fluoride as a post-harvest fumigant for dry fruits, nuts, and grains under the trade name ProFume (EPA Reg. No. 62719- 376-AA). Most recently Drexel Chemical Company has registered Master Fume (EPA Reg. No. 19713-596-AA) for the structural market, competing against Vikane and Zythor.

Pest fumigation is a dangerous operation. It must be carried out by competent personnel or registered pest control companies that are in possession of the correct certification that allows them to perform pest fumigation operations.

Other Fumigation Treatments

Demon WP
Demon WP is used against a variety of insects and commonly used to control cockroaches. It is an odorless chemical which provides up to 90 days of protection. The active ingredient in Demon WP is Cypermethrin 40.0%; it may be used inside or outside of the house. The chemical is acceptable for use in federally licensed meat, poultry and egg processing plants. Demon WP will not hold up in a water solution. A gallon of Demon WP will cover 2,000 to 2,500 square feet of home or business space. It will not damage or stain any plastic, varnished or painted surface where it is applied.

Cyonara 9.7
Cyonara 9.7 is a multi-purpose pesticide commonly used for fumigating cockroaches. It is suitable for use indoors and outdoors in homes, commercial establishments, agricultural areas and food handling areas. The active ingredient in Cyonara 9.7 is 9.7% Lambda-Cyhalothrin, and the pesticide will last up to seven months when applied. Do it Yourself Pest Control recommends reapplying every two to three months to ensure effectiveness. In concentration, one quart of Cyonara 9.7 produces between 39 to 157 gallons of usable pesticide. A typical house needs from 1 to 2 gallons for a proper fumigation.

Cyper WP
Cyper WP comes in a white powder and is mixed with water. When applied, the mixture lasts between two and three months with a 1-pound container producing about 24 to 48 gallons of cockroach fumigation chemicals. A 1-pound container will cover 2,000 to 2,500 square feet of commercial or residential space. The product is odorless and suitable for use indoors or outdoors, but will leave a powder chemical residue on dark furniture or dark surface spaces.
It is suitable for use in residential, commercial, agricultural and industrial spaces. In conditions where it rains often, the product should be applied more regularly. The chemical is toxic to fish, so any fish tanks should be covered before application.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

Why Rinse Empty Pesticide Containers?

Proper rinsing of pesticide containers is easy to do, saves money, and helps protect people and the environment. It also helps prevent potential problems with un-rinsed containers, rinsate storage, and pesticide wastes. Even during a busy season the few extra minutes it takes to properly rinse empty pesticide containers is time well spent.

- Rinsate from the containers, when added directly into the sprayer tank, efficiently and economically uses all pesticide in the container. This eliminates the need to store and later dispose of the rinsate.
- Unless rinsed from the container immediately, some pesticides will solidify and become difficult to remove.
- Rinsing containers removes a potential source of pesticide exposure to people, animals, and wildlife.
- Proper rinsing is required by federal and state regulations and is a good, sound agricultural and environmental practice.

Rinsing Helps Protect the Environment
Proper rinsing of pesticide containers reduces a potential source of contamination of soil, surface, and ground water. When contamination occurs, plants and animals may be harmed and water supplies affected. Prevention of environmental contamination is always better than cleanup. Rinsing also helps in reducing the problem of handling pesticide wastes.

No matter how an empty pesticide container is disposed of, **it must be properly rinsed and triple punched.**

Both federal and state laws require rinsing. Landfill operators and recyclers can only accept properly rinsed containers.

Pesticide containers should only be offered to recycling projects designed for pesticide containers and not general plastic and metal recycling programs. Pesticide container recycling project personnel will inspect containers to determine if they have been properly rinsed.

Rinsing is Effective

Pesticide residues measured in selected containers that passed visual inspection in the test project show rinsing at the time of use is effective:

Percent of pesticide residue removed with proper rinsing		
Pesticide	**Container**	**% Removal**
2, 4-D	2.5 gallon plastic	99.9999
pendimethalin	2.5 gallon plastic	99.9969
alachlor	5.0 gallon metal	99.9998
glyphosate	1.0 gallon plastic	99.9989
metolachlor	2.5 gallon plastic	99.9999
carbofuran	2.5 gallon plastic	99.9993

Types of Pesticide Containers

Currently the most common agricultural pesticide container is a 2.5 gallon plastic jug. Agricultural, animal, household, and other pesticide products also come packaged in glass, paper, metal and aerosol cans. Many liquid agricultural pesticides are also sold in returnable bulk containers and mini-bulk containers. Only plastic, glass and un-pressurized metal containers can be rinsed. Ease of handling and proper disposal should be considered when purchasing pesticides.

How to Properly Rinse

Two different procedures are effective for proper rinsing of pesticide containers: pressure-rinsing and triple-rinsing.

Pressure-Rinsing

A special nozzle is attached to the end of a hose to force the remaining pesticide from the container. Pressure-rinsing, which may be faster and easier than triple-rinsing, can be used with plastic and non-pressurized metal pesticide containers.

How to Pressure-Rinse

1. Remove cover from container. Check cover and container threads for pesticide. Rinse covers separately in a bucket of water for more than one minute and pour this rinse water into the spray tank.
2. Empty pesticide into the spray tank and let container drain for 30 seconds.
3. Insert pressure-nozzle by puncturing through the lower side of the pesticide container.
4. Hold the container upside down over the sprayer tank opening so rinsate will run into the sprayer tank.
5. Rinse for length of time recommended by the manufacturer (generally 30 seconds or more). Wiggle nozzle to rinse all inside surfaces. Be sure hollow handles are well rinsed.
6. Let container dry and then put cover back on container.

Triple-Rinsing

It means rinsing the container three times. Triple-rinsing can be used with plastic, non-pressurized metal, and glass containers.

How to Triple-Rinse

1. Remove cover from the container.
2. Empty the pesticide into the sprayer tank and let the container drain for 30 seconds.
3. Fill the container 10% to 20% full of water or rinse solution.
4. Secure the cover on the container.
5. Swirl the container to rinse all inside surfaces.
6. Remove cover from the container. Add the rinsate from the container to sprayer tank and let drain for 30 seconds or more.
7. Repeat steps 2 through 5 **two more times.**
8. Let container dry and then put cover back on container. Triple punch the bottom.

Remember

- To read and to follow all label instructions.
- To wear appropriate protective gear when working with pesticides.
- Never reuse a pesticide container for any purpose.
- To dispose of all pesticide containers properly.
- When not using a water nurse tank, always use a back-flow prevention device when filling sprayer tanks or rinsing pesticide containers.
- Mixing and loading sites should be at least 150 feet away from all wells.

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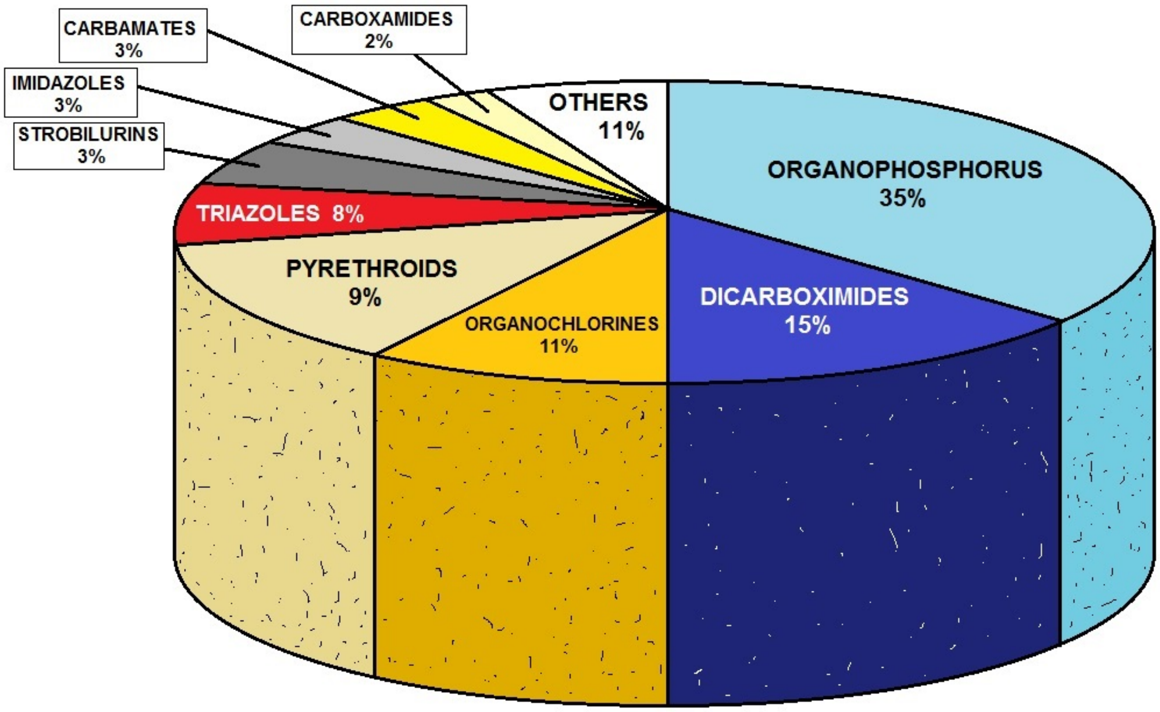


PERCENTAGE OF PESTICIDE BY CHEMICAL CLASSIFICATION

Federal Pesticide Recordkeeping Requirements

Questions and Answers
Final regulations to implement requirements in section 1491 of the Food, Agriculture, Conservation, and Trade (**FACT**) Act of 1990, commonly referred to as the 1990 Farm Bill, went into effect **May 10, 1993.** On February 10, 1995 amendments to the regulations were published, which become effective on May 11, 1995. The regulations are administered by the U.S. Department of Agriculture's Agricultural Marketing Service (**AMS**).

Why are there regulations for restricted use pesticide recordkeeping for certified private applicators? The FACT Act of 1990, subtitle H, section 1491, states that the Secretary of Agriculture, in consultation with the Administrator of the Environmental Protection Agency (**EPA**), ***"shall require certified applicators of restricted use pesticides..... to maintain records comparable to records maintained by commercial applicators of pesticides in each State."*** Certified applicators include both commercial and private applicators.

CATEGORY	NONREFILLABLE CONTAINERS	REFILLABLE CONTAINERS	REPACKING PESTICIDE PRODUCTS	CONTAINER LABELING	CONTAINMENT STRUCTURES
WHO MUST COMPLY	REGISTRANTS	REGISTRANTS REFILLERS (Retailers, Distributors)	REGISTRANTS REFILLERS (Retailers, Distributors)	REGISTRANTS PESTICIDE USERS (Must Follow New Directions)	AG RETAILERS AG COMMERCIAL APPLICATORS AG CUSTOM BLENDERS
MAJOR REQUIREMENTS	• DOT CONTAINER DESIGN, CONSTRUCTION AND MARKING STANDARDS • CONTAINER DISPENSING CAPABILITY • STANDARD CLOSURES • RESIDUAL REMOVAL • RECORDKEEPING	• DOT CONTAINER DESIGN, CONSTRUCTION AND MARKING STANDARDS • SERIAL NUMBER MARKING • ONE-WAY VALVES OR TAMPER-EVIDENT DEVICES • STANDARD CONTAINER REQUIREMENTS	• DOT CONTAINER DESIGN, CONSTRUCTION AND MARKING STANDARDS • SERIAL NUMBER MARKING • ONE-WAY VALVES OR TAMPER-EVIDENT DEVICES • STANDARD CONTAINER REQUIREMENTS	• IDENTIFY CONTAINER AS NONREFILLABLE OR FILLABLE (All) • STATEMENTS TO PROHIBIT REUSE AND OFFER FOR RECYCLING; BATCH CODE (All Nonrefillables) • CLEANING INSTRUCTIONS • CLEANING INSTRUCTONS BEFORE FINAL DISPOSAL	•SECONDARY CONTAINMENT STRUCTURES (Dikes) AROUND STATIONARY TANKS •CONTAINMENT PADS FOR PESTICIDE DISPENSING AREAS •GOOD OPERATING PROCEDURES •MONTHLY INSPECTION OF TANKS AND STRUCTURES •RECORDKEEPING
COMPLIANCE DATE	AUGUST 17, 2009	AUGUST 17, 2011	AUGUST 17, 2011	AUGUST 16, 2011 (Based on the October 8, 2010 Final Rule)	AUGUST 17, 2009

PESTICIDE CONTAINER AND CONTAINMENT RULE

Technical Learning College

The EPA currently requires certified commercial applicators to keep records under regulations implementing the Federal Insecticide, Fungicide, and Rodenticide Act (**FIFRA**). The EPA is prohibited from requiring certified private applicators to maintain records. However, some individual States require certified private applicators to maintain records.

Do the regulations apply to all pesticide applications? No. The regulations only require recordkeeping for applications of federally-restricted use pesticides. Pesticides are classified as restricted use, general use, or for both uses.

Is a Federal form required for maintaining the record(s)? No. The regulations do not require the use of a standardized form. This allows applicators the flexibility to fit the recordkeeping requirements into their current recordkeeping scheme.

What information is a certified private applicator required to maintain on a restricted use pesticide application? The recordkeeping requirements are:

1. The brand or product name, and the EPA registration number of the restricted use pesticide that was applied;
2. The total amount of the restricted use pesticide applied;

3. The location of the application, the size of area treated, and the crop, commodity, stored product, or site to which a restricted use pesticide was applied;
4. The month, day, and year when the restricted use pesticide application occurred; and
5. The name and certification number (if applicable) of the certified applicator who applied or who supervised the application of the restricted use pesticide.

When does the pesticide application information have to be recorded? The information required shall be recorded within 14 days following the pesticide application.

How long are records required to be kept? Restricted use pesticide records must be retained by the applicator for 2 years from the date of application and made available to individuals who are authorized to have access to the record information.

Certified applicators have no reporting requirements under the regulations.

Who has authorization to obtain record information from the certified applicator? Individuals representing the Secretary of Agriculture or the State designated agency, which is most commonly the State Department of Agriculture. Also the attending licensed health care professional, or an individual acting under the direction of the attending licensed health care professional, is authorized access to record information when it is determined the information is needed to provide medical treatment or first aid to an individual who may have been exposed to the restricted use pesticide for which the record is maintained.

Are there any penalties for violation of the Federal pesticide recordkeeping requirements? Yes. Any certified applicator who violates the requirements shall be subject to a civil penalty of not more than $500 in the case of the first offense, and shall be subject to a civil penalty of not less than $1000 for each violation for subsequent offenses, except that the civil penalty shall be less than $1000 if the Administrator determines that the certified applicator made a good faith effort to comply.

AMENDMENTS TO THE REGULATIONS - EFFECTIVE MAY 11, 1995

1. **Change in the way the location of a "spot application" is recorded.**
   A" spot application" is an application(s) of a restricted use pesticide made on the same day in a total area of less than one-tenth of an acre. This provision still does not apply to records maintained for greenhouse and nursery applications.

   The regulations were amended to require a more detailed description of the location of a ***"spot application."*** Spot applications must be recorded with the following information: Brand or product name and EPA registration number; total amount applied; location must be designated as ***"spot application,"*** followed by a concise description of the location (**Examples:** Spot application, noxious weeds were spot sprayed throughout field number 5 and 6. Spot application, sprayed for weeds next to the silo); and month, day, and year of application.

2. **Shortened the time period to make a record of the restricted use pesticide application.**
   The time period was reduced from 30 days to 14 days for the required information to be legibly recorded following the restricted use pesticide application.

   However, whether or not the written record has been completed, the certified applicator shall provide the record information for medical treatment or first aid.

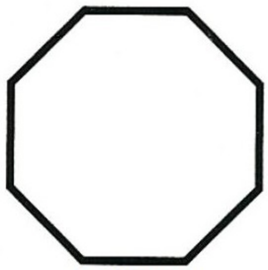
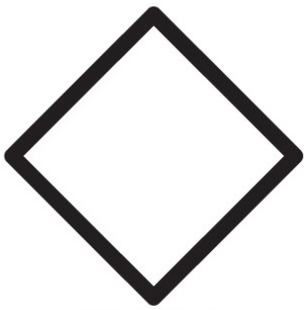
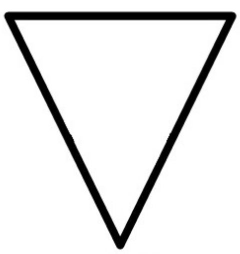
3. **Change in the definition of a medical emergency.**
   A medical emergency is defined as a situation that requires immediate medical treatment or first aid to treat possible symptoms of pesticide poisoning or exposure.

4. **Change in the definition of a licensed health care professional.**
   A licensed health care professional is defined as a physician, nurse, emergency medical technician, or other qualified individual, licensed or certified by a State to provide medical treatment.

5. **Change in accessing records to facilitate medical treatment.**
   When the attending licensed health care professional, or an individual acting under the direction of the attending licensed health care professional, determines that any record of the application of any restricted use pesticide required to be maintained is necessary to provide medical treatment or first aid to an individual who may have been exposed to the restricted use pesticide for which the record is or will be maintained, the certified applicator required to maintain the record shall promptly provide the record information and any available label information. If it is determined by the attending licensed health care professional, or an individual acting under the direction of the attending licensed health care professional, to be a medical emergency, the record information of the restricted use pesticide, relating to the medical emergency, shall be provided immediately.

6. **Change in provisions for the release of record information obtained for purposes of medical treatment.**
   (1) The attending licensed health care professional, or an individual acting under the direction of the attending licensed health care professional, may utilize and release the record or record information when necessary to provide medical treatment or first aid to an individual who may have been exposed to the ' restricted use pesticide for which the record is or will be maintained;
   (2) the attending licensed health care professional may release the record or record information to appropriate Federal or State agencies that deal with pesticide use or any health issue related to the use of pesticides when necessary to prevent further injury or illness; and
   (3) a licensed health care professional may release the record or record information to submit pesticide poisoning incident reports to the appropriate State or Federal agencies.

7. **Clarification that the Administrator of AMS, has flexibility in assessing civil penalties.**
   The amended regulations provide the Administrator of AMS, or the Administrator's designee, with flexibility in assessing civil penalties.

SYMBOL	SIGNAL WORD DEGREE OF HAZARD	 NATURE OF PRIMARY HAZARD	SYMBOL
 DANGER	**DANGER** LD_{50} Less than 500 mg/kg HIGH TOXICITY REQUIRES: Goggles Respirator Gloves Skin Protection Avoid the Fumes and Mist	**POISON**	
 WARNING	**WARNING** LD_{50} 500 - 1000 mg/kg MODERATE TOXICITY REQUIRES: Goggles Gloves Skin Protection Avoid the Fumes and Mist	**CORROSIVE**	
 CAUTION	**CAUTION** LD_{50} 1000 - 2500 mg/kg LOW TOXICITY REQUIRES: Gloves Skin Protection Avoid the Fumes and Mist	**FLAMMABLE**	
		EXPLOSIVE	

GRAPH DEPICTING DEGREE OF RISK & HAZARD SYMBOLS RELATED TO PESTICIDES

Personal Protective Equipment Sub-Section

Pesticides are necessary for agricultural production but potential hazards to users are not adequately emphasized. Accidents involving pesticides are usually due to improper handling, mixing, application of pesticides, or failure to use proper personal protective equipment and clothing.

General Guidelines
The minimum protection when working with pesticides is long sleeves, long pants, shoes and socks, rubber gloves, and splash-proof eye protection, regardless of the toxicity level of the pesticide. Rubber boots and a respirator are necessary when working with moderately or highly toxic pesticides. The EPA's recommendations include wearing a double layer of clothing. This can be accomplished by wearing coveralls over the long pants and longsleeve shirt, and rubber boots over the shoes and socks.

Gloves
The use of gloves is mandatory when working with highly toxic pesticides. It is recommended that only unlined rubber or neoprene (nitrile, etc.) gloves be used when handling or using all pesticides. Unlined gloves should be thoroughly washed (inside and outside) after each use.

Gloves should be at least 12 inches long to provide adequate protection for wrists and the cuffs should be inside sleeves for most work. This will keep runoff pesticide from getting into the gloves. However when working overhead put the cuffs of gloves outside sleeves.

Check rubber type gloves for leaks each time they are washed. Do this by filling gloves with water and fold the cuff over to put pressure on the water in the glove. If there are holes water will leak out. Discard gloves with leaks. **NEVER USE CLOTH OR LEATHER GLOVES WHEN WORKING WITH PESTICIDES** unless specified on the label.

Goggles and Face Shields
It is necessary to wear splash-proof goggles when working with pesticides. Not only can the pesticide be absorbed through the eyes but the acidity of a pesticide can cause permanent eye injuries also. Use goggles meeting or exceeding ANSI standard Z87.1, 1968 estimate. When pouring or mixing concentrates it is preferable to use a full-face shield to protect the face from splashes. Always wash the goggles or face shield with soap and water after use.

Boots
Unlined rubber or neoprene (nitrile, etc.) boots should be worn over work shoes or in place of work shoes when mixing or applying pesticides. Pull the legs of trousers over the tops of boots to help prevent spilled pesticide from getting inside boots. Wash boots with soap and water after each use.

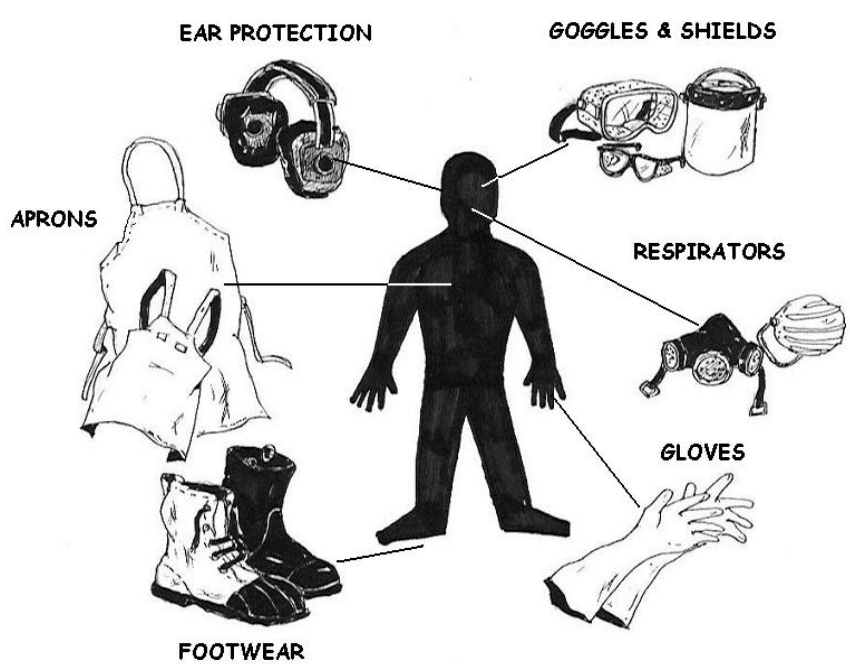
NEVER WEAR CLOTH OR LEATHER BOOTS WHEN MIXING, OR APPLYING PESTICIDES. Cloth or leather boots will absorb pesticides and allow the pesticide to contact the skin of the leg or foot and will be a source of residues causing chronic exposure.

Headwear
A waterproof hat should be worn when mixing or applying pesticides because pesticides can be readily absorbed through the scalp. The hat should have a brim to keep drift or splashes off ears and neck. Plastic safety hats are ideal for use with pesticides and should be washed in soap and water after each use. Cloth hats may absorb pesticides and contaminate the wearer. **DO NOT USE CLOTH HATS.**

Respirators
Respirators are designed to prevent inhaling toxic fumes and mists. They should be used when mixing or applying pesticides if the label specifies the need. Choose the correct cartridge for the type of pesticide being used. The manufacturer or supplier can provide guidance on selecting correct cartridges.

Replace cartridges when the odor of the pesticide becomes noticeable or when breathing becomes difficult during use. The life of cartridges will vary with the concentration of pesticide in the air around the respirator breathing rate of the user temperature humidity and composition of the cartridge. Respirators **SHOULD NOT** be used in low oxygen atmospheres (below 19.5 percent oxygen). Respirators **WILL NOT** provide adequate protection for a person having a beard. Choose the model and make of respirator that provides a good seal between the face piece and the face to prevent pesticides from leaking into the respirator and being breathed.

Always wash the face piece and straps in soap and water after each use. After drying place the respirator and cartridges in a clean plastic bag until they are needed again. Select respirators having the approval of NIOSH or MESA.



NORMAL APPLICATOR PPE

Respirator Storage

Respirators are to be stored as follows:

- All respirators shall be stored to protect them from damage, contamination, dust, sunlight, extreme temperatures, excessive moisture, and damaging chemicals, and they shall be packed or stored to prevent deformation of the face piece and exhalation valve.
- Emergency Respirators shall be:
- Kept accessible to the work area;
- Stored in compartments or in covers that are clearly marked as containing emergency respirators; and
- Stored in accordance with any applicable manufacturer instructions.

We will cover more in detail on respirators later

NORMAL MIXER/HANDLER PPE

Always wear the proper PPE. The venoms of the AHB and the EHB are almost identical. Medical literature provides no evidence suggesting that AHB stings are more toxic than EHB stings. The amount of venom per sting does vary between the AHB and the EHB, with the AHB having approximately 27 percent less venom per sting. The smaller size of the AHB is the primary reason for the smaller amount of venom.

Always wear your bee suit even while inspecting the hive. Most applicators are stung during their inspection. Numerous insecticides are approved for use on bees. These chemicals are very effective when used properly. Soapy water doesn't work effectively on a colony because honeycomb prevents adequate coverage.

Bee colonies may be removed physically by hand or by vacuuming with special types of vacuums. Once collected, the bees can be placed in a hive, released at a different location, or killed with insecticide. The bulb seems to be the best at killing bees and wasps, but beware, they will go after you and it takes a couple of years to get over the fear of the entire hive attacking you.

Respiratory Protection Sub- Section

General
In the Respiratory Protection program, hazard assessment and selection of proper respiratory PPE is conducted in the same manner as for other types of PPE. In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination.

This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used.

References: OSHA Standards ***Respiratory Protection*** (29 CFR 1910.134)

Why Respirators Are Needed
Respirators protect against the inhalation of dangerous substances (vapors, fumes, dust, gases). They can also provide a separate air supply in a very hazardous situation.

Some of the health hazards that respirators prevent include:
- *Lung damage*
- *Respiratory diseases*
- *Cancer and other illnesses.*

Respiratory Protection Responsibilities:
The employer is responsible for,

- Providing training in the use and care of respirators
- Ensuring that equipment is adequate, sanitary, and reliable
- Allowing employees to leave area if ill, for breaks, and to obtain parts
- Fit testing
- Providing annual medical evaluation
- Providing a powered air-purifying respirator (**PAPR**) if an employee cannot wear a tight-fitting respirator

The employee is responsible for:
- Properly using respirators
- Maintaining respirator properly
- Reporting malfunctions
- Reporting medical changes

Selection of Respiratory Protection
When choosing the correct respiratory protection for your work environment, it is important to consider:

- Identification of the substance or substances for which respiratory protection is necessary
- A substance's safety data sheet (**SDS**) (it will state which type of respirator is most effective for the substance)
- Activities of the workers
- Hazards of each substance and its properties
- Maximum levels of air contamination expected
- Probability of oxygen deficiency
- Period of time workers will need to use the respiratory protection devices
- Capabilities and physical limitations of the device used

Basic Types of Respirators
Air-purifying or filtering respirators. Such respirators are used when there is enough oxygen (at least 19.5 percent) and contaminants are present below IDLH level.

The respirator filters out or chemically "***scrubs***" contaminants, usually with a replaceable filter. Use color-coded filter cartridges or canisters for different types of contaminants. It's important to select the right filter for the situation.

Air-supplying respirators. These respirators are required when air-purifying respirators aren't effective. Air-purifying respirators are not sufficient in the following settings:
- When there is not enough oxygen
- Confined spaces
- When contaminants cannot be filtered out
- When contaminants are at or above IDLH level.

Different kinds of Air-Supplying Respirators include
- Those connected by hose to stationary air supply (air line)
- Portable tank self-contained breathing apparatus (**SCBA**).

The Importance of Correct Fit
Even a tiny gap between the respirator and the face can allow contaminants to enter. Respirators should be comfortable and properly fitted. Proper fit includes:
- Secure but not too tight
- No slipping or pinching
- Allowance for head movement and speech

An OSHA-accepted qualitative fit test or quantitative fit test must be performed prior to an employee using any tight-fitting respirator.

Tight-fitting respirators must be seal checked before each use by using positive- or negative-pressure check procedures or the manufacturer's instructions.

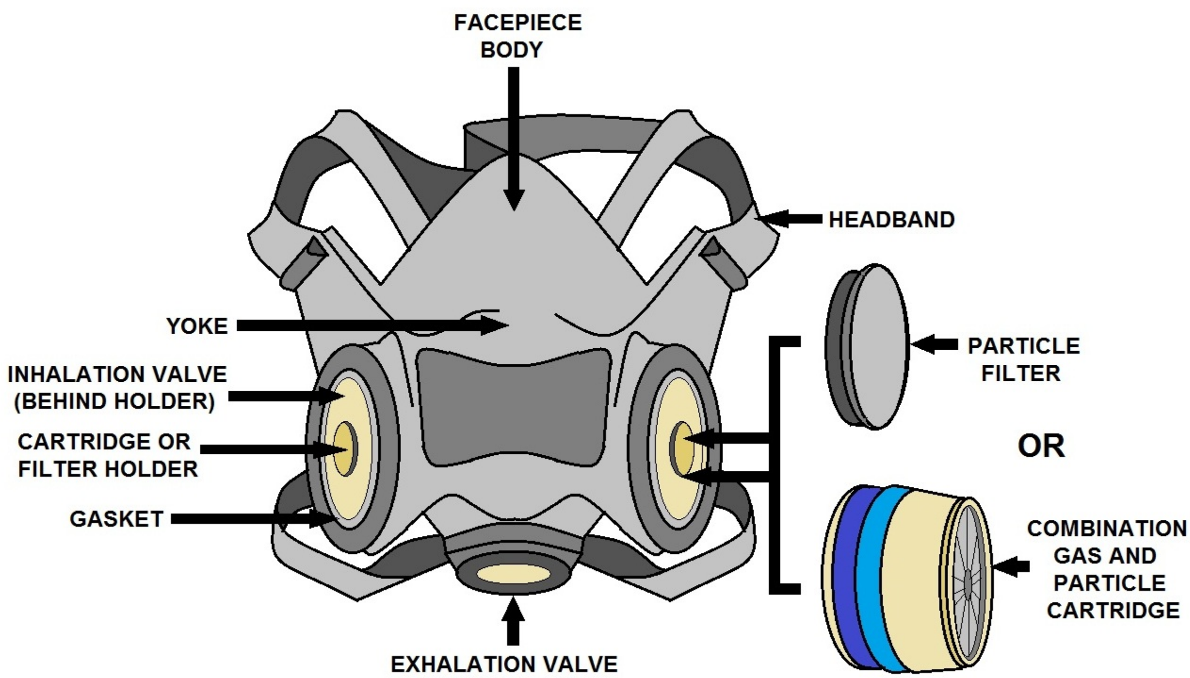
Respirator Filters/Cartridges
For protection against gases and vapors, the cartridges used for air-purifying respirators must be either equipped with an end-of-service-life indicator (**ESLI**), certified by NIOSH for the contaminant, or a cartridge change schedule has to be established.

For protection against particulates, there are nine classes of filters (three levels of filter efficiency, each with three categories of resistance to filter efficiency degradation). Levels of filter efficiency are 95 percent, 99 percent, and 99.97 percent. Categories of resistance to filter efficiency degradation are labeled N, R, and P.

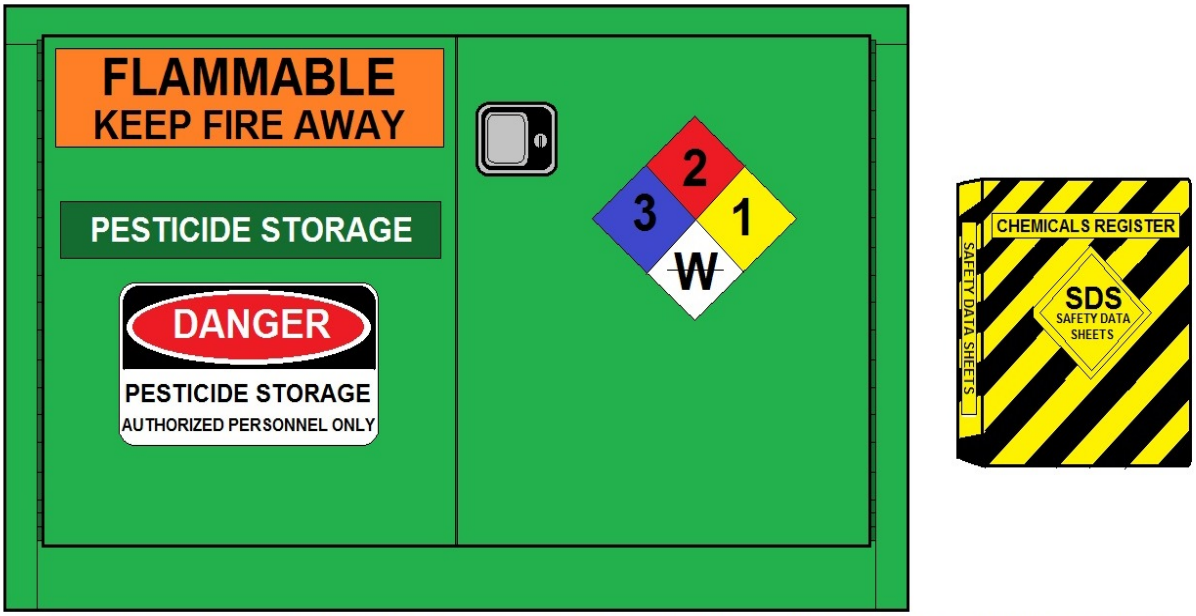
Protection Factors
The protection factor of a respirator is an expression of performance based on the ratio of two concentrations: The contaminant concentration outside the respirator to the contaminant concentration inside the respirator.

Each class of respirator is also given an assigned protection factor (**APF**). The APF is a measure of the minimum anticipated level of respiratory protection that a properly functioning respirator or class of respirators would provide to a percentage of properly fitted and trained users.

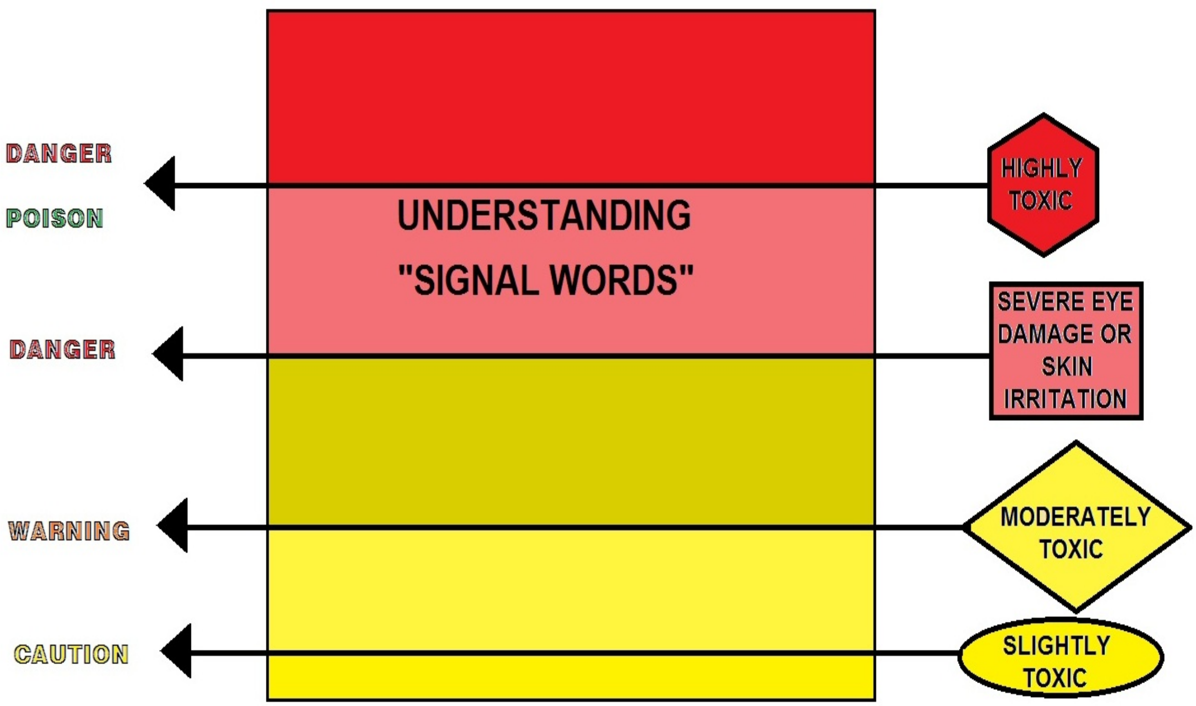
When a contaminant concentration is known, the APF can be used to estimate the concentration inside a particular type of respirator worn by a user.



BASIC PARTS OF A HALF-FACEPIECE RESPIRATOR



STORE PESTICIDES IN PROPER STORAGE CABINETS AND ENSURE THAT SAFETY DATA SHEETS ARE READILY AVAILABLE IN CENTRAL LOCATION



Who Cannot Wear a Respirator?

Respirator fit is essential. Employees must have a medical checkup to make sure they can wear respirators safely. Generally, respirators cannot be worn when a person:

- Wears glasses or personal protective equipment that interferes with the seal of the face piece to the face of the user
- Has facial hair that comes between the sealing surface of the face piece and the face or interferes with valve function
- Has a breathing problem, such as asthma
- Has a heart condition
- Is heat sensitive

Sometimes a person's facial features will not permit a good fit. Check with the supervisor or medical department if the fit is a problem.

Checking for Damage
Before each use, make sure there are no holes, tears, etc., in the respirator. Rubber parts can wear out and should be checked very carefully every time a respirator is used. Replace worn and damaged parts when necessary. Make sure air and oxygen cylinders are fully charged.

Staying Prepared for Respirator Use
Respirators are bulky and awkward, so getting used to them takes practice. Possible problems with wearing respirators may include heat exhaustion or heat stroke. Be alert for symptoms, use the "buddy system," and wear a lifeline or harness when necessary. Drink plenty of fluids and take frequent breaks.

Poor maneuverability. Practice with respirators in narrow passages, on ladders, etc., if your use of respirators may be in these types of conditions.

Using up the air supply. When a SCBA is in use, keep checking the gauges and listening for alarms; be ready to leave the area immediately if there is a problem.

Panic. Remember the importance of staying calm in a hot, stressful, or awkward situation.

Cleaning Respirators
Respirators should be cleaned and disinfected after every use. Check the respirator for damage before putting it away; look for holes, cracks, deterioration, dented cartridges, etc. If any damage is found, it should be reported to a supervisor. Respirators stored for emergency use must be inspected monthly when not in use, as well as after each use.

Respirators should be stored away from light, heat, cold, chemicals, and dust. Store respirators in a "***normal***" (natural, undistorted) position to hold their shape. Do not allow respirators to get crushed, folded, or twisted.

Overview

OSHA requires that supervisors consult with employees and encourage their participation in the process safety management plan. In fact, managers must have a written plan of action for employee participation in process safety management. Employee participation is critical because;

- Employees know a lot about the process they work on.
- They play key roles in making sure that process operation is conducted safely.

Operating Procedures

Managers must furnish written operating procedures that clearly explain how to perform each covered process safely. The procedures must be accurate and must be written in language that employees can understand. Avoid technical jargon and, if necessary, supply translations.

Operating procedures must include at least the following:

- Operating steps for initial startup, normal and temporary operations, emergency shutdown (including when it's called for and who does it), emergency operations, normal shutdown, and startup after a turnaround or an emergency shutdown.

- Operating limits, including what happens if workers don't conform to operating limits and how to avoid or correct such problems.

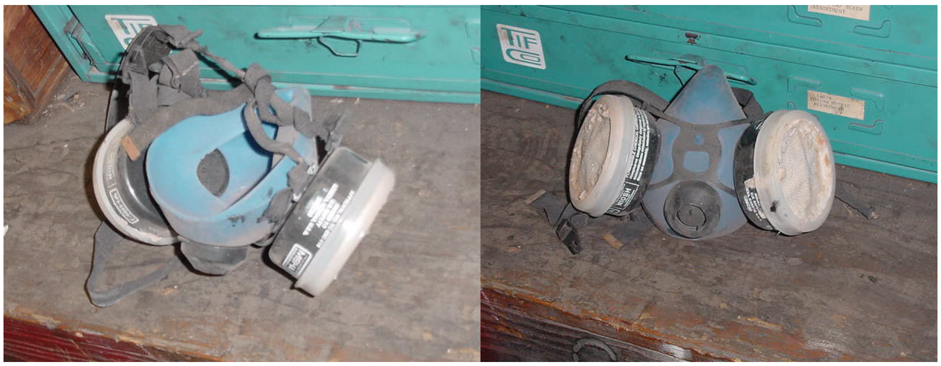
- Safety and health considerations, such as chemical or other hazards, precautions to prevent exposure, quality and inventory control for chemicals, and what to do if an employee is exposed to a hazardous substance.

- Safety systems and their functions, including up-to-date operating procedures and safe work practices.

Respirator Filter & Canister Replacement

An important part of the Respiratory Protection Program includes identifying the useful life of canisters and filters used on air-purifying respirators. Each filter and canister shall be equipped with an end-of-service-life indicator (**ESLI**) certified by NIOSH for the contaminant; ***or***

If there is no ESLI appropriate for conditions, a change schedule for canisters and cartridges that is based on objective information or data that will ensure that canisters and cartridges are changed before the end of their service life.



Unacceptable maintenance and storage. (OSHA Violation)

Filter & Cartridge Change Schedule
Stock of spare filters and cartridges shall be maintained to allow immediate change when required or desired by the employee.

Cartridges shall be changed based on the most limiting factor below:

- Prior to expiration date
- Manufacturers recommendations for the specific use and environment
- After each use
- When requested by employee
- When contaminate odor is detected
- When restriction to air flow has occurred as evidenced by increase effort by user to breathe normally
- Cartridges shall remain in their original sealed packages until needed for immediate use

Filters shall be changed on the most limiting factor below:

- Prior to expiration date
- Manufacturers recommendations for the specific use and environment
- When requested by employee
- When contaminate odor is detected
- When restriction to air flow has occurred as evidenced by increase effort by user to breathe normally
- When discoloring of the filter media is evident
- Filters shall remain in their original sealed package until needed for immediate use.

Respiratory Protection Schedule by Job and Working Condition
The Employer needs to maintain a Respiratory Protection Schedule by Job and Working Condition. This schedule is provided to each authorized and trained Employee.

The Schedule provides the following information:
1. Job/Working Conditions
2. Work Location
3. Hazards Present
4. Type of Respirator or SCBA Required
5. Type of Filter/Canister Required
6. Location of Respirator or SCBA
7. Filter/Cartridge change out schedule

The schedule will be reviewed and updated at least annually and whenever any changes are made in the work environments, machinery, equipment, or processes or if different respirator models are introduced or existing models are removed.

Permanent respirator schedule assignments are:
Each person who engages in welding will have their own Employer provided dust-mist-fume filter APR. This respirator will be worn during all welding operations.

Physical and Medical Qualifications
Records of medical evaluations must be retained and made available in accordance with 29 CFR 1910.1020.

Medical evaluation required
Using a respirator may place a physiological burden on employees that varies with the type of respirator worn, the job and workplace conditions in which the respirator is used, and the medical status of the employee. The Employer is required to provide a medical evaluation to determine the employee's ability to use a respirator before the employee is fit tested or required to use the respirator in the workplace.

Medical evaluation procedures
The employee will be provided a medical questionnaire by the designated Occupational Health Care Provider

Follow-up Medical Examination

The Employer shall ensure that a follow-up medical examination is provided for an employee who gives a positive response to any question among questions in Part B of the questionnaire or whose initial medical examination demonstrates the need for a follow-up medical examination. The follow-up medical examination shall include any medical tests, consultations, or diagnostic procedures that the Physician deems necessary to make a final determination.

Administration of the medical questionnaire and examinations
The medical questionnaire and examinations shall be administered confidentially during the employee's normal working hours or at a time and place convenient to the employee. The medical questionnaire shall be administered in a manner that ensures that the employee understands its content. The Employer shall provide the employee with an opportunity to discuss the questionnaire and examination results with the Physician.

Supplemental information for the Physician.
The following information must be provided to the Physician before the Physician makes a recommendation concerning an employee's ability to use a respirator

- The type and weight of the respirator to be used by the employee
- The duration and frequency of respirator use (including use for rescue and escape)
- The expected physical work effort
- Additional protective clothing and equipment to be worn
- Temperature and humidity extremes that may be encountered
- Any supplemental information provided previously to the Physician regarding an employee need not be provided for a subsequent medical evaluation if the information and the Physician remain the same

The Employer has provided the Physician with a copy of the written respiratory protection program and a copy of the OSHA Standard 1910.134

Medical Determination

In determining the employee's ability to use a respirator, the Employer shall:

- Obtain a written recommendation regarding the employee's ability to use the respirator from the Physician. The recommendation shall provide only the following information.
- Any limitations on respirator use related to the medical condition of the employee, or relating to the workplace conditions in which the respirator will be used, including whether or not the employee is medically able to use the respirator.
- The need, if any, for follow-up medical evaluations.
- A statement that the Physician has provided the employee with a copy of the Physician's written recommendation.
- If the respirator is a negative pressure respirator and the Physician finds a medical condition that may place the employee's health at increased risk if the respirator is used, the Employer shall provide an APR if the Physician's medical evaluation finds that the employee can use such a respirator; if a subsequent medical evaluation finds that the employee is medically able to use a negative pressure respirator, then the Employer is no longer required to provide an APR.

Additional Medical Evaluations
At a minimum, the Employer shall provide additional medical evaluations that comply with the requirements of this section if:

- An employee reports medical signs or symptoms that are related to ability to use a respirator.
- A Physician, supervisor, or the respirator program administrator informs the Employer that an employee needs to be reevaluated.
- Information from the respiratory protection program, including observations made during fit testing and program evaluation, indicates a need for employee reevaluation.
- A change occurs in workplace conditions (e.g., physical work effort, protective clothing, and temperature) that may result in a substantial increase in the physiological burden placed on an employee.

Respirator Fit Testing (see Appendix A for more information)
Before an employee is required to use any respirator with a negative or positive pressure tight-fitting face piece, the employee must be fit tested with the same make, model, style, and size of respirator that will be used. The Employer shall ensure that an employee using a tight-fitting face piece respirator is fit tested prior to initial use of the respirator, whenever a different respirator face piece (size, style, model or make) is used, and at least annually thereafter.

The Employer has established a record of the qualitative and quantitative fit tests administered to employees including:

- The name or identification of the employee tested
- Type of fit test performed
- Specific make, model, style, and size of respirator tested
- Date of test
- The pass/fail results for QLFTs or the fit factor and strip chart recording or other recording of the test results for QNFTs

Additional fit tests will be conducted whenever the employee reports, or the Employer, Physician, supervisor, or program administrator makes visual observations of, changes in the employee's physical condition that could affect respirator fit. Such conditions include, but are not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight.

If after passing a QLFT or QNFT, the employee notifies the Employer's program administrator, supervisor, or Physician that the fit of the respirator is unacceptable, the employee shall be given a reasonable opportunity to select a different respirator face piece and to be retested.

Types of Fit Tests
The fit test shall be administered using an OSHA-accepted QLFT or QNFT protocol. The OSHA-accepted QLFT and QNFT protocols and procedures are contained in Appendix A of OSHA Standard 1910.134.

- QLFT may only be used to fit test negative pressure air-purifying respirators that must achieve a fit factor of 100 or less.
- If the fit factor, as determined through an OSHA-accepted QNFT protocol, is equal to or greater than 100 for tight-fitting half face pieces, or equal to or greater than 500 for tight-fitting full face pieces, the QNFT has been passed with that respirator.
- Fit testing of tight-fitting atmosphere-supplying respirators and tight-fitting powered air-purifying respirators shall be accomplished by performing quantitative or qualitative fit testing in the negative pressure mode, regardless of the mode of operation (negative or positive pressure) that is used for respiratory protection.
- Qualitative fit testing of these respirators shall be accomplished by temporarily converting the respirator user's actual face piece into a negative pressure respirator with appropriate filters, or by using an identical negative pressure air-purifying respirator face piece with the same sealing surfaces as a surrogate for the atmosphere-supplying or powered air-purifying respirator face piece.
- Quantitative fit testing of these respirators shall be accomplished by modifying the face piece to allow sampling inside the face piece in the breathing zone of the user, midway between the nose and mouth. This requirement shall be accomplished by installing a permanent sampling probe onto a surrogate face piece, or by using a sampling adapter designed to temporarily provide a means of sampling air from inside the face piece.
- Any modifications to the respirator face piece for fit testing shall be completely removed, and the face piece restored to NIOSH approved configuration, before that face piece can be used in the workplace.

Fit test records shall be retained for respirator users until the next fit test is administered. Written materials required to be retained shall be made available upon request to affected employees.

Respirator Operation and Use
Respirators will only be used following the respiratory protection safety procedures established in this program. The Operations and Use Manuals for each type of respirator will be maintained by the Program Administrator and be available to all qualified users.

Surveillance by the direct supervisor shall be maintained of work area conditions and degree of employee exposure or stress. When there is a change in work area conditions or degree of employee exposure or stress that may affect respirator effectiveness, the Employer shall reevaluate the continued effectiveness of the respirator.

For continued protection of respirator users, the following general use rules apply:

- Users shall not remove respirators while in a hazardous environment.
- Respirators are to be stored in sealed containers out of harmful atmospheres.
- Store respirators away from heat and moisture.
- Store respirators such that the sealing area does not become distorted or warped.
- Store respirator such that the face piece is protected.
- Face piece seal protection.

The Employer does not permit respirators with tight-fitting face pieces to be worn by employees who have:

- Facial hair that comes between the sealing surface of the face piece and the face or that interferes with valve function; or
- Any condition that interferes with the face-to-face piece seal or valve function.

If an employee wears corrective glasses or goggles or other personal protective equipment, the Employer shall ensure that such equipment is worn in a manner that does not interfere with the seal of the face piece to the face of the user.

Continuing Effectiveness of Respirators
The Employer shall ensure the following that employees leave the respirator use area:

- To wash their faces and respirator face pieces as necessary to prevent eye or skin irritation associated with respirator use
- If they detect vapor or gas breakthrough, changes in breathing resistance, or leakage of the face piece
- To replace the respirator or the filter, cartridge, or canister elements.

If the employee detects vapor or gas breakthrough, changes in breathing resistance, or leakage of the face piece, the Employer will replace or repair the respirator before allowing the employee to return to the work area.

Procedures for IDLH Atmospheres
For all IDLH atmospheres, the Employer shall ensure that:

- One employee or, when needed, more than one employee is located outside the IDLH atmosphere
- Visual, voice, or signal line communication is maintained between the employee(s) in the IDLH atmosphere and the employee(s) located outside the IDLH atmosphere
- The employee(s) located outside the IDLH atmosphere are trained and equipped to provide effective emergency rescue
- The Employer or designee is notified before the employee(s) located outside the IDLH atmosphere enter the IDLH atmosphere to provide emergency rescue
- The Employer or designee authorized to do so by the Employer, once notified, provides necessary assistance appropriate to the situation

Employee(s) located outside the IDLH atmospheres will be equipped with:

- Pressure demand or other positive pressure SCBAs, or a pressure demand or other positive pressure supplied-air respirator with auxiliary SCBA; and either
- Appropriate retrieval equipment for removing the employee(s) who enter(s) these hazardous atmospheres where retrieval equipment would contribute to the rescue of the employee(s) and would not increase the overall risk resulting from entry; or
- Equivalent means for rescue where retrieval equipment is not required.

Cleaning and Disinfecting

The Employer shall provide each respirator user with a respirator that is clean, sanitary, and in good working order. The Employer shall ensure that respirators are cleaned and disinfected using the Standard Operating Procedure SOP: **Cleaning and Disinfecting.**

The respirators shall be cleaned and disinfected when:

- Respirators issued for the exclusive use of an employee shall be cleaned and disinfected as often as necessary to be maintained in a sanitary condition.
- Respirators issued to more than one employee shall be cleaned and disinfected before being worn by different individuals.
- Respirators maintained for emergency use shall be cleaned and disinfected after each use.
- Respirators used in fit testing and training shall be cleaned and disinfected after each use.

Cleaning and Storage of respirators assigned to specific employees is the responsibility of that Employee.

Respirator Inspection

All respirators/SCBAs, both available for "***General Use***" and those on "***Permanent Check-out***", will be inspected after each use and at least monthly. Should any defects be noted, the respirator/SCBA will be taken to the program Administrator. Damaged Respirators will be either repaired or replaced. The inspection of respirators loaned on "***Permanent Check-out***" is the responsibility of that trained Employee.

Respirators shall be inspected as follows:

- All respirators used in routine situations shall be inspected before each use and during cleaning.
- All respirators maintained for use in emergency situations shall be inspected at least monthly and in accordance with the manufacturer's recommendations, and shall be checked for proper function before and after each use.
- Emergency escape-only respirators shall be inspected before being carried into the workplace for use.

Respirator inspections include the following:

- A check of respirator function, tightness of connections, and the condition of the various parts including, but not limited to, the face piece, head straps, valves, connecting tube, and cartridges, canisters or filters.
- Check of elastomeric parts for pliability and signs of deterioration.
- Self-contained breathing apparatus shall be inspected monthly. Air and oxygen cylinders shall be maintained in a fully charged state and shall be recharged when the pressure falls to 90% of the manufacturer's recommended pressure level. The Employer shall determine that the regulator and warning devices function properly.

For Emergency Use Respirators the additional requirements apply:

- Certify the respirator by documenting the date the inspection was performed, the name (or signature) of the person who made the inspection, the findings, required remedial action, and a serial number or other means of identifying the inspected respirator.
- Provide this information on a tag or label that is attached to the storage compartment for the respirator, is kept with the respirator, or is included in inspection reports stored as paper or electronic files. This information shall be maintained until replaced following a subsequent certification.

Respirator Storage

Respirators are to be stored as follows:

- All respirators shall be stored to protect them from damage, contamination, dust, sunlight, extreme temperatures, excessive moisture, and damaging chemicals, and they shall be packed or stored to prevent deformation of the face piece and exhalation valve.

Emergency Respirators shall be:

- Kept accessible to the work area;
- Stored in compartments or in covers that are clearly marked as containing emergency respirators; and
- Stored in accordance with any applicable manufacturer instructions.

Repair of Respirators

Respirators that fail an inspection or are otherwise found to be defective will be removed from service to be discarded, repaired or adjusted in accordance with the following procedures:

- Repairs or adjustments to respirators are to be made only by persons appropriately trained to perform such operations and shall use only the respirator manufacturer's NIOSH-approved parts designed for the respirator;
- Repairs shall be made according to the manufacturer's recommendations and specifications for the type and extent of repairs to be performed; and
- Reducing and admission valves, regulators, and alarms shall be adjusted or repaired only by the manufacturer or a technician trained by the manufacturer.

Breathing Air Quality and Use

The Employer shall ensure that compressed air, compressed oxygen, liquid air, and liquid oxygen used for respiration accords with the following specifications:

- Compressed and liquid oxygen shall meet the United States Pharmacopoeia requirements for medical or breathing oxygen; and
- Compressed breathing air shall meet at least the requirements for Grade D breathing air described in ANSI/Compressed Gas Association Commodity Specification for Air, G-7.1-1989, to include:
- Oxygen content (**v/v**) of 19.5-23.5%;
- Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less;
- Carbon monoxide (**CO**) content of 10 ppm or less;
- Carbon dioxide content of 1,000 ppm or less; and
- Lack of noticeable odor.
- Compressed oxygen will not be used in atmosphere-supplying respirators that have previously used compressed air.
- Oxygen concentrations greater than 23.5% are used only in equipment designed for oxygen service or distribution.
- Cylinders used to supply breathing air to respirators meet the following requirements.
- Cylinders are tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR part 173 and part 178).

- Cylinders of purchased breathing air have a certificate of analysis from the supplier that the breathing air meets the requirements for Grade D breathing air.
- Moisture content in breathing air cylinders does not exceed a dew point of -50 deg. F (-45.6 deg. C) at 1 atmosphere pressure.
- Breathing air couplings are incompatible with outlets for nonrespirable worksite air or other gas systems. No asphyxiating substance shall be introduced into breathing air lines.
- Breathing gas containers shall be marked in accordance with the NIOSH respirator certification standard, 42 CFR part 84.

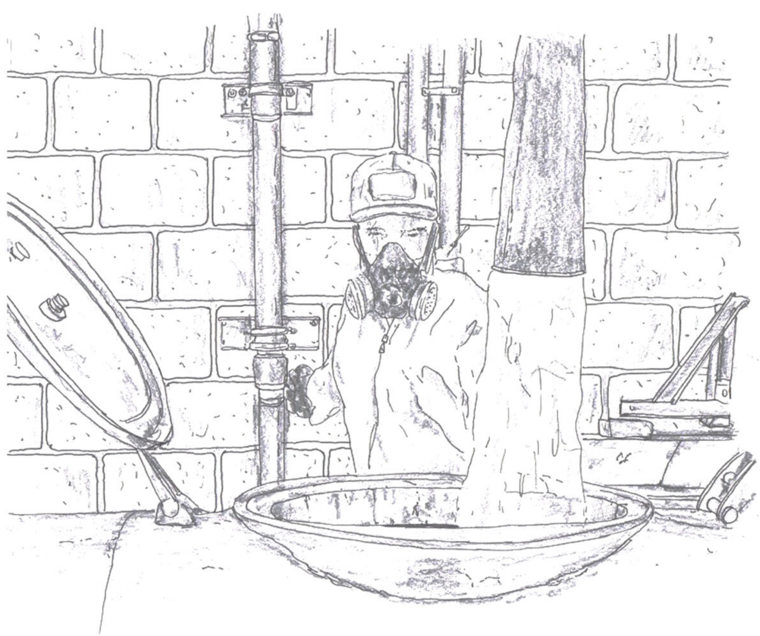
Summary

Following this training session, employees should:

- Wear the respirator assigned to him or her.
- Always check for fit before wearing.
- Always check for damage and deterioration before wearing.
- Know when to replace canisters and cartridges.
- Practice maneuvering with a respirator.
- Store carefully in the proper location.

Personal Protective Equipment Summary

(i) Personal protective equipment (PPE) means devices and apparel that are worn to protect the body from contact with pesticides or pesticide residues, including, but not limited to, coveralls, chemical- resistant suits, chemical-resistant gloves, chemical-resistant footwear, respiratory protection devices, chemical-resistant aprons, chemical-resistant headgear, and protective eyewear.
(ii) Long-sleeved shirts, short-sleeved shirts, long pants, short pants, shoes, socks, and other items of work clothing are not considered personal protective equipment for the purposes of this section and are not subject to the requirements of this section, although pesticide labeling may require that such work clothing be worn during some activities.
(iii) When "chemical-resistant" personal protective equipment is specified by the product labeling, it shall be made of material that allows no measurable movement of the pesticide being used through the material during use.
(iv) When "waterproof" personal protective equipment is specified by the product labeling, it shall be made of material that allows no measurable movement of water or aqueous solutions through the material during use.
(v) When a "chemical-resistant suit" is specified by the product labeling, it shall be a loose-fitting, one- or two-piece, chemical-resistant garment that covers, at a minimum, the entire body except head, hands, and feet.
(vi) When "coveralls" are specified by the product labeling, they shall be a loose-fitting, one- or two-piece garment, such as a cotton or cotton and polyester coverall, that covers, at a minimum, the entire body except head, hands, and feet. The pesticide product labeling may specify that the coveralls be worn over a layer of clothing. If a chemical-resistant suit is substituted for coveralls, it need not be worn over a layer of clothing.



Pesticide Application Section Post Quiz

1. _____________of pesticide containers is easy to do, saves money, and helps protect people and the environment.

2. Rinsate from the containers, when added directly into the sprayer tank, efficiently and economically uses all pesticide in the container. This eliminates the need to store and later dispose of the________________.

3. Unless rinsed from the container immediately, some pesticides will _____________and become difficult to remove.

4. Proper rinsing is required by _____________regulations and is a good, sound agricultural and environmental practice.

5. Proper rinsing of pesticide containers reduces a ___________of soil, surface, and ground water. When contamination occurs, plants and animals may be harmed and water supplies affected. Prevention of environmental contamination is always better than cleanup. Rinsing also helps in reducing the problem of handling pesticide wastes.

What information is a certified private applicator required to maintain on a restricted use pesticide application? The recordkeeping requirements are:

6. The brand or product name, and the ____________of the restricted use pesticide that was applied;

7. The ____________of the restricted use pesticide applied;

8. The____________, the size of area treated, and the crop, commodity, stored product, or site to which a restricted use pesticide was applied;

9. The month, day, and year when the __________occurred; and

10. The ___________(if applicable) of the certified applicator who applied or who supervised the application of the restricted use pesticide.

Answers

1. Proper rinsing, 2. Rinsate, 3. Solidify, 4. Federal and state, 5. Potential source of contamination, 6. EPA registration number, 7. Total amount, 8. location of the application, 9. Restricted use pesticide application, 10. Name and certification number

Pesticide/Insect Glossary

Acaricide: A pesticide used to control mites and ticks. Same as miticide.
Adhesive: A substance which will cause a spray material to stick to the sprayed surface, e.g., sticking agent.
Adjuvant: Any substance added to pesticide which improves the activity of the active ingredient. ***Examples***: Penetrates, spreader-stickers and wetting agents.
Adventive: Located outside habitat, though an reproductive population may not be established.
Alates: Winged forms of insects.
Anthocorids: A true bug in the family Anthocoridae.
Aphid: An insect in the family Aphididae which is sometimes called plant lice.
Algaecide (Algicide): A pesticide used to kill or inhibit the growth of algae.
Alien: Same as non-native.
Anti-Transpirant: A chemical applied directly to a plant which reduces the rate of transpiration, or water loss, by the plant.
Avicide: A chemical used to kill birds.
Bactericide: Chemical used to kill bacteria.
Band Application: The application of a pesticide or other material to a limited area such as in or beside a crop row rather than over the entire field area.
Beneficial insect: Any insect that has a life style that is advantageous to man. Insects that preserve the balance of nature by feeding on others, pollinators, and recyclers are examples of beneficial insects.
Cephalothorax: Head (ceph) and chest (thorax) area.
Cerci: Paired appendages on the end of the abdomen of many insects which are used for sensing, defense or mating.
Chewing (mouth parts): Any mouth part that literally bites to feed; other mouth part types are sucking and rasping.
Clavus: The enlarged terminal antennal segments that form a club
Collophore: A tube-like structure on the underside of the first abdominal segment (folds under the body) of Collembola (e.g. springtails) which is used as a spring action for leaping.
Broad Spectrum Application: General purpose pesticides which can be used against a large number of pests on a wide range of crops.
Broadcast Application: The application of a pesticide or other material over the entire field or area.
Calibrate: To determine the amount of pesticide that will be applied to the target area.
Colonizing: An ant species which is successful at creating nests in new areas. While some exotic ants are successful colonizers, many colonizing species are not exotic -- and many exotics are not colonizers.
Compound eyes: The large multi-faceted eyes of insects.
Coreids: A member of the family Coreidae, which are leaf footed bugs**.**
Corium: The elongate, thickened basal portion of the fore wing of Hemiptera.
Cornicles: Tubular structure on each side of abdominal region from which pheromones or honeydew is expelled.
Coxa (pl.=coxae): Basal portion of the leg.
Crepuscular: Having activity periods during low light levels at dawn and evening.
Cursorial: Adapted for running.
Coverage: Spread of a pesticide chemical over a surface such as the leaves, fruit, stem, etc.
Dactyl: Literally, a finger or fingerlike projection on an insect body part.
Dealates: Winged forms that have shed their wings, like reproductive termites or ants.
Defoliate, defoliation: Removal of foliage from plants, often by chewing insects.
Detritivore: Any organism that eats decaying organic matter.
Diapause: An insect resting stage, usually induced by environmental signals or extreme

conditions like winter or summer.
Dimorphic: Having two distinct forms.
Defoliant: A chemical which causes the leaves or foliage to drop from a plant.
Desiccant: A chemical that promotes drying or loss of moisture.
Drift: The airborne movement of a pesticide spray or dust from the target area to an area not intended to be treated.
Dust: A finely ground, dry pesticide formulation usually containing a small amount of active ingredient and a large amount of inert carrier or dilutent such as clay or talc.
Emulsifiable Concentrate: A pesticide formulation produced by dissolving the active ingredient and an emulsifying agent in a suitable solvent. When added to water, an emulsion (milky mixture) is produced.
Endosperm: A portion of a seed which contains most of the energy reserves for germination.
Estivation (aestivation) : A resting stage (quiescence) resulting from continued high temperature or xeric conditions; diapause; hibernation.
Exoskeleton: The outer portion of an insect body which may be relatively soft like a caterpillar or hardened like many beetles.
Femora: A segment of an insect leg; usually the largest segment.
Filiform: Linear shaped, as the antennae of ground beetles.
Forbs: Any broadleaf non-woody (herbaceous) plant.
Frass: Solid larval insect excrement; plant fragments made by wood-boring insects, usually mixed with excrement.
Furculum (plural: furcula): The elongate fork-like appendage on the end of the abdomen.
Exotic: Same as non-native.
Eradication: The complete elimination of either weeds, insects, disease organisms, or other pests from an area.
Fumigant: A chemical that forms vapors (gases) which is used to destroy weeds, plant pathogens, insects or other pests.
Fungicide: A chemical that kills or inhibits fungi.
gpm.: Gallons per minute.
Genera: Plural of genus; A genus is a group of plants or animals with similar characteristics. Animals (insects) are classified by kingdom, phylum, class, order, family, genus, species, and author’s name. For example, the honey bee is classified as Animal (kingdom), Arthropoda (phylum), Insecta or Hexapoda (class), Hymenoptera (order), Apidae (family), *Apis* (genus), *mellifera* (species), Linnaeus (author's name). The genus and species are always italicized.
Girdle, girdling: Damage of a plant that circles the stem or branch cutting off the connective plant tissue.
Grigology: The study of crickets, grasshoppers and katydids.
Hemelytron: The first wing of a true bug (Hemiptera) which has the base more thickened than the membranous outer portion.
Hopperburn: Leaf damage caused by leafhopper feeding, which is a yellowing of the leaves.
Herbicide A pesticide used for killing or preventing plant growth. A weed or grass liquid.
Imago: The adult stage of an insect.
Instar: An insect stage between molts; molting is growth.
Internode: The part of a plant stem between the nodes. Nodes mark the point of attachment of leaves, flowers, fruits, buds and other stems.
Insecticide: A pesticide that is used to kill, inhibit, repel or otherwise prevent damage by pests.
Introduced: Same as non-native.
Invasive: A species which is spreading its geographic range into niches occupied by other species. Documentation of an invasive species requires an ecological study to demonstrate the displacement of other ants.
Larval stage (larva, larvae): An immature insect, sometimes used to include all immature stages, even eggs. Usually this term refers more specifically to the feeding stages of insects

with complete metamorphosis like grubs, caterpillars, and maggots.
Maggot: In most Diptera (flies), legless larva lacking a distinct head, with cephalic (head) end pointed and caudal (rear) end blunt.
Mesophyll: Fleshy plant tissue inside a leaf or stem.
Metamorphosis: **-** change in form during an insect's growth and development.

Gradual metamorphosis - incomplete metamorphosis in which there is no pupal stage and the immatures and adults look similar excluding the wings of the adults.

Incomplete metamorphosis - any metamorphosis type that does not include the pupal stage. Incomplete metamorphosis is present in Orthoptera (grasshoppers), Hemiptera (true bugs), and several other orders.

Simple metamorphosis - any metamorphosis that occurs in insect groups where they are not winged and have no pupal stage. Insect groups with simple metamorphosis include the Collembola (springtails) and Thysanura (silverfish).

Metathorax: The second section of the insect thorax which houses the second pair of legs and the first pair of wings.
Mite: A member of the order Acari (ticks and mites)
Molt, molting process: In insects, as in snakes, the process of shedding the exoskeleton.
Naiad: A term for immature insects that are aquatic from the orders Plecoptera, Odonata, and Ephemeroptera. This term is becoming archaic and is now replaced by the more general term "***immature***" insect.
Necrosis: Death of tissue in plants or animals.
Nymphs: An immature stage of hemimetabolous insects (those with incomplete metamorphosis).
Microbial Pesticide: Bacteria, viruses, fungi and other microorganisms used to destroy or control pests.
Miticide: See acaricide.
Molluscicide: A chemical used to kill or control snails and slugs.
Native: These definitions do not necessarily define *where* a species is native. How do I define where a species is native? Sometimes the non-native status of a species is clear from previous collections and existing knowledge from biogeography and systematics. Other times, boundaries are a lot blurrier. Is a species non-native if it has been there for 400 years?
Nematicide: A pesticide that kills or otherwise controls nematodes.
Non-indigenous: Same as non-native.
Non-native: A species which is established outside its native habitat. With respect to ants, ants with an established reproducing colony.
Oothecae: A bean-like hardened egg capsule produced by female cockroaches.
Osmeterium (pl.=osmeteria): Scent-producing area behind the tibia.
Overwinter: Time spent during the winter months. Insects are often in hibernation or at least rather immobile in the colder temperatures.
Ovipositor: The egg laying apparatus of an insect. The stinger of a bee is actually a modified ovipositor.
Parthenogenesis: Egg development without fertilization.
Pedipalps: Second pair of appendages of the cephalothorax corresponding to the mandibles of insects.
Petiole: Attachment of a leaf to stem.
Phloem and xylem: Vascular tubes that allow fluid transport in plants. It is the way plants receive and distribute nutrients, hormones and water.
Photosynthesis: The chemical process that plants use to convert carbon dioxide and water to sugars and ultimately to energy.
Phyto- (prefix): Plant.
Phytophagous: Plant eating; an insect using plants as a food source.
Phytotoxemia: A toxic reaction in plants.
Poikilotherm: A cold-blooded organism.

Proboscis: A nose, or, in the case of butterflies, the coiled sucking mouthpart.
Pronotum: The plate on top of the prothorax.
Prothorax: The front part of an insect thorax which includes the attachment points for the front legs.
Protozoan: A microorganism in the kingdom Protozoa.
Pseudergates: Caste found in the lower termites (Isoptera), comprised of individuals having regressed from nymphal stages by molts eliminating the wing buds, or being derived from larvae having undergone non-differentiating molts, serving as the principle elements of the worker caste, but remaining capable of developing into other castes by further molting.
Psocids: Any insect in the order Psocoptera, which includes booklice and barklice.
Psyllid yellows: A virus disease of potatoes, tomatoes, peppers, and eggplant. See purple top.
Pupal stage (pupa): The stage in complete metamorphosis between larva and adult like the cocoon in moths.
Purple top: A purple discoloration of foliage tips caused by insect transmitted virus.
Pustulate: Pus-forming, as in spider bites.
Pesticide: A chemical or other agent used to kill or otherwise control pests.
Pisicicide: A chemical used to kill undesirable fish.
Postmergence: After the plants have appeared through the soil.
Protectant: A pesticide applied to a plant or animal prior to the appearance or occurrence of the pest in order to prevent infection or injury by the pest.
Repellant: A compound that keeps or drives away insects, rodents, birds or other pests from plants, domestic animals, buildings or other treated areas.
Rhopalid: An insect in the family Rhopalidae in the order Hemiptera (true bugs).
Rosetting: Malformation of a plant resulting in a bunched irregular growth of the leaves.
Rodenticide: A pesticide, or mixture of pesticides, used to kill or control rodents.
Scutellum: A triangular shaped section on the back of Hemiptera and some Coleoptera. It is often the identifying characteristic of Hemipterans or "***true bugs***".
Secondary reproductive: A caste of subterranean termite; also called supplemental reproductives. If these termites develop from nymphs, they are called secondary reproductives (primary reproductives are the king and queen). If they develop from pseudergates, they are called tertiary reproductives. Supplementals may be responsible for most of the egg production in the colony.
Spinneret: A small tubular appendage from which silk threads by spiders and many larval insects are excreted.
Stippling (leaf): A speckled appearance of a leaf, usually yellowish spots on a green leaf.
Stolon: An underground portion of a plant that grows horizontally, like a grass root.
Subgroup: A subset of a group with related characters. The term group is a general and non-specific collection of similar organisms regardless of taxonomic hierarchy.
Subimago: The first winged stage of a mayfly. This is the only group to have a winged stage that molts. The final stage is the imago, or adult.
Silvicide: A pesticide used to destroy woody shrubs and trees.
Soluble Powder: A finely ground, solid material which will dissolve in water or some other liquid carrier.
Space Spray: A pesticide which is applied as a fine spray or mist to a confined area either indoors or outside.
Target: The plants, animals, structure, areas or pests to be treated with a pesticide application.
Tarsi: A foot. Insect feet are made of several segments and may have pads, hairs, or hooks.
Tegmina: Plural of tegmen, a hardened covering like the forewing of many Orthoptera and Hemiptera.
Tenaculum: A minute two-pronged structure on the underside of the third abdominal segment of Collembola (springtails) which holds the furcula (appendage used for jumping) before it is released to jump.
Termite: Any wood-eating insect in the order Isoptera.

soldier termite - a caste of termites with specific structures to defend the colony, such as large mandibles or nasute mouths that produce sticky defensive substances.
worker termite - a caste of termites that do most of the work in the colony. Worker termites can be all immature termites and forms that do not develop into reproductive forms or soldiers.

Tertiary reproductive termite: See secondary reproductive.

Tettigoniid: A family of Orthoptera, often called long-horned grasshoppers, which includes katydids.

Thorax: The second body segment of an insect. The thorax has all of the wings and legs attached to it.

Tip burn: A yellow or dried tip on a branch or leaf caused by insect feeding or a plant physiology disorder.

True bugs: Insects in the order Hemiptera. They are usually characterized by a scutellum, a triangular shaped section on the back.

Tramp: A widespread ant species spread by human commerce with a specific syndrome of life history characteristics: extreme polygyny, unicolonial or highly polydomous nest structure and colony reproduction by budding (sensu Passera 1994).

Transferred: Collected outside native habitat, without knowledge of established nests.

Transported: Same as transferred; often refers to animals found in quarantine inspection.

ULV: Ultra Low Volume. No water is applied with this pesticide formulation. Spray concentrates are frequently used in ULV applications.

Venation: The pattern of veins in the insect wing.

Wettable Powder: A solid (powder) pesticide formulation which forms a suspension when added to water.

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