GENERAL PEST CONTROL

TRAINING COURSE

PROFESSIONAL DEVELOPMENT
CONTINUING EDUCATION COURSE

Technical Learning College

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

State Approval Listing URL…
http://www.tlch2o.com/PDF/CEU%20State%20Approvals.pdf

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Library of Congress Card Number 6558661
ISBN 978-0-9799559-9-0

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.

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 format and you are welcome to examine this material on your computer with no obligation. 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 do finish the material on your leisure. Students can also receive course materials through the mail. The CEU course or e-manual will contain all your lessons, activities and 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.

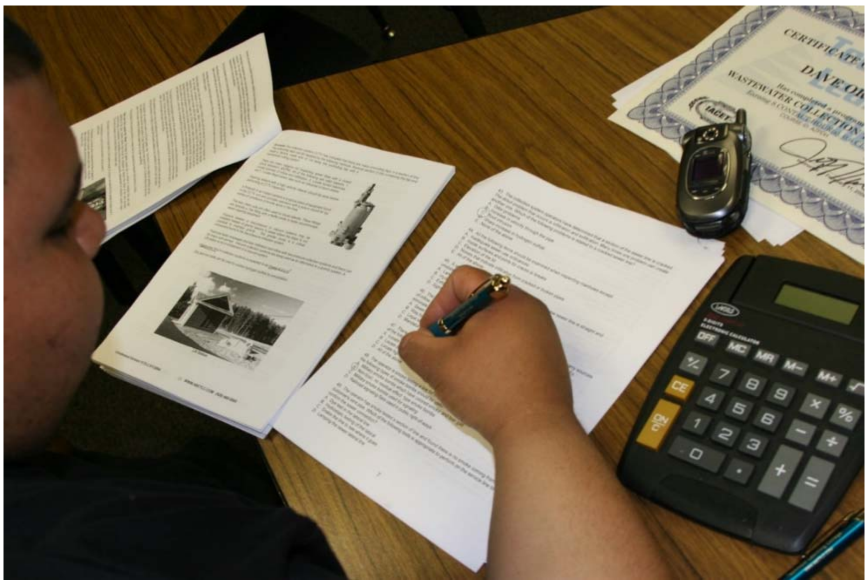
Flexible Learning
At TLC, there are no scheduled online sessions or passwords you need contend with, nor are you required to participate in learning teams or groups designed for the "typical" younger campus based student. You will work at your own pace, completing assignments in time frames that work 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 are assigned at the beginning of each course providing the academic support you need to successfully complete each course.

No Data Mining Policy
Unlike most online training providers, we do not use passwords or will upload intrusive data mining software onto your computer. We do not use any type of artificial intelligence in our program. Nor will we sell you any other product or sell your data to others as with many of our competitors. Unlike our training competitors, we have a telephone and we humanly answer.

Satisfaction Guaranteed
We have many years of experience, dealing with thousands of students. We assure you, our customer satisfaction is second to none. This is one reason we have taught more than 20,000 students.



We welcome you to do the electronic version of the assignment and submit the answer key and registration to us either by fax or e-mail. If you need this assignment graded and a certificate of completion within a 48-hour turn around, prepare to pay an additional rush charge of $50.

We welcome you to complete the assignment in Word.

Once we grade it, we will mail a certificate of completion to you. Call us if you need any help.

Contact Numbers
Fax (928) 468-0675
Email Info@tlch2o.com
Telephone (866) 557-1746

CEU Course Description

This CEU course covers general pests and control methods. This course will also cover basic pesticide safety training and the federal pesticide rule. It will also cover understanding various types of pesticides, application methods, insect identification and control methods, aerial application, 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 teach the student proper pest identification, and how to safety apply the proper treatment to the target. The student will learn effective and safe pesticide application, aerial application methods, insect identification and control methods and various pesticide treatment methods and clean-up procedures.

Learning Objectives
- Ability to explain commonly found pests (insects) and their physical characteristics.
- Ability to describe proper pest treatment methods.
- Ability to explain pesticides, various forms and their proper applications and purposes.
- Define different pesticide treatment terminology, including antimicrobial pesticides, biopesticides, regulated biopesticides, and organophosphate.
- Ability to identify and explain different pesticide safety and related safe-handling terms, including HAZCOM and SDS, Right to Know.
- Interpret and explain denotative and connotative meanings of different types of pest control, devices, applications, methods and associated rules.
- Ability to identify various EPA pesticide and safety concerns, rules, and regulations, including Standard for Pesticide Handler and Standards for Pesticides Applicators. Develop an ability to identify different aerial pesticides and explain crop treatment application; identify different aerial application terms, including particle size, spray nozzles, spray patterns, understand associated laws and required training and difficult worker/handler terms.

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 General Pest Control correspondence 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 70% 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 rear 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.

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.

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.

A second certificate of completion for a second State Agency $25 processing fee.

Many States and employers require the final exam to be proctored.

Important Information about this Manual

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 pesticides or 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 pesticides or 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.

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Pesticide Applicator Observations

Right photograph, 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.

Top photograph, old fashioned hose reel spray set-up.

Yes, old fashioned. 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, 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.

The item on the right 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 to boot.

The photograph above 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 switchplates. You have to get in to 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 the pests. If you can't kill spiders or know someone that complains about not being able to kill spiders, then you know who I am talking about. Know your pest, its habitat, and know your product!

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. I like to use Phantom products in it and it works like dynamite on ants and termites alike. Notice the two red backpacks on this truck. Always have a backup backpack. Now go out there and pour a little coffee for the pest of the week.

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. Always follow the label instructions.

Utilizing the same application gun, here is an example of a bait that is the ideal means of targeted elimination of 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 (Great on Ants too)
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 are 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 nonrepellent 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 follow the label instructions.

Cockroaches have been here since before Adam and Eve. 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 know, I hate seeing German cockroaches because I've seen such large infestations in homes and restaurants. But this product has shown success in killing those little critters. 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. Always follow the label instructions.

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 use 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.) Always follow the label instructions.

Two bad things 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 insecticide 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, warehouses 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 follow the label instructions.

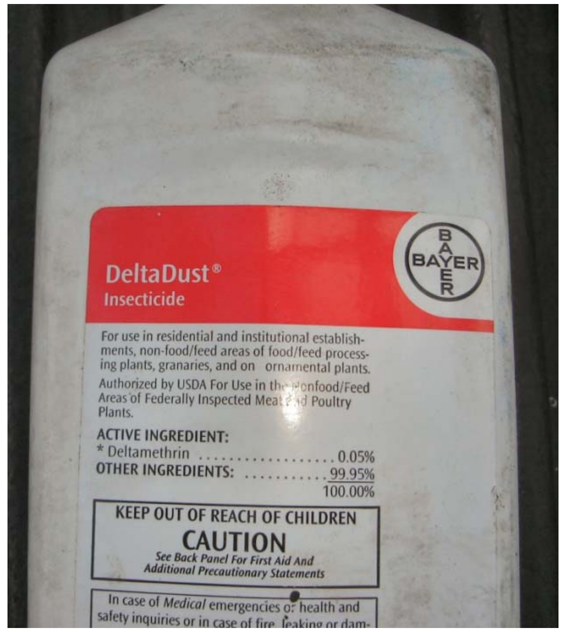
Although the name has changed from Gencor to Gentrol, the active ingredient is still Hydroprene. The label for this product has been broadened to include not only roaches (cockroaches) but also many pantry pests, also known as stored product pests. The only stored product pest that does not react well 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.

Other than nasty ticks, spiders and scorpins are very difficult to treat. I always welcome your comments, suggestions on both pesticides and insects.

Delta Dust



Delta Dust (i.e., Deltamethrin .05%). I am not here to endorse this product, but I have found great success inside wall voids. It will kill cockroaches, 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. It provides quick control of ants, bees (especially carpenter bees), cockroaches, fleas, silverfish, ticks, and numerous stored product pests. It's also an invaluable tool for controlling boxelder bugs, ladybugs, white footed ants and pavement ants. Deltamethrin is a synthetic pyrethroid insecticide.

I hate to 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.

No, I do not own stock in Delta or Bayer. Nor do they pay me, either. If you have a good product, let me know. Always follow the label instructions.

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 is very long lasting. Cy-Kick is the choice of many professional pest companies; it is good but not cheap. It will kill scorpions. Always follow the label instructions.

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.

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. Always follow the label instructions.

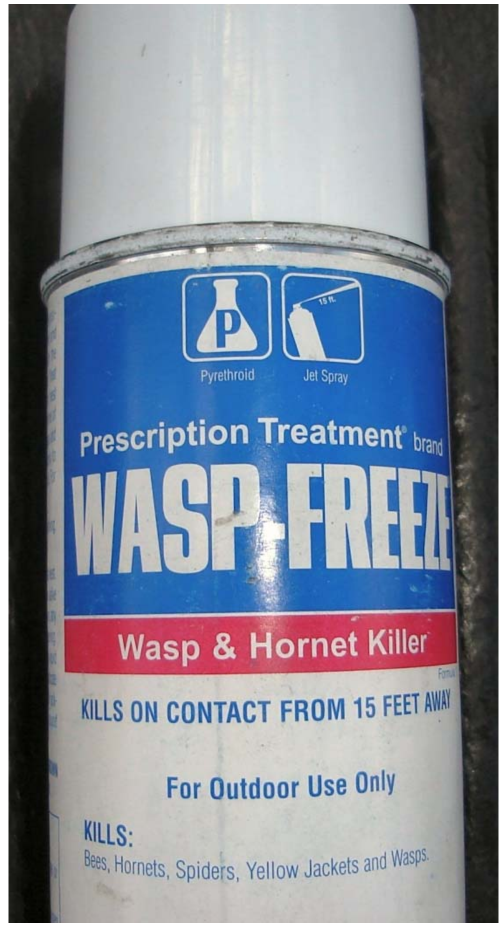
Talstar One

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, 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. Always follow the label instructions.

Wasp Freeze



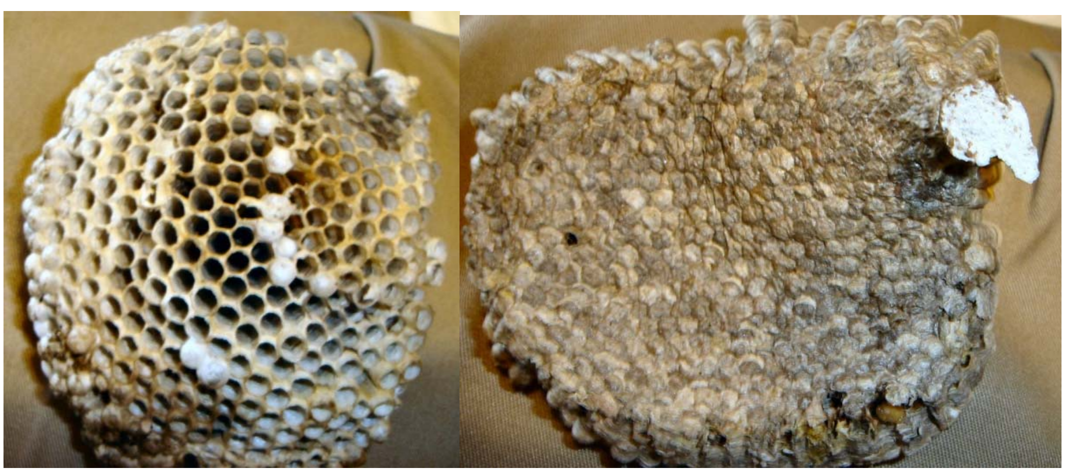
Here is one of my favorite products-- I am not trying to promote the brand name, but any one who mixes a freezing agent with a pesticide is either crazy or a genius; either way, the two are very close, and this is a wonderful product. I wish I would have though of it first.

By the way, 40 giant wasps can destroy a honey bee hive and kill the entire hive in less than four hours. Wasps are nasty by nature. They can bite or sting. They where designed by God as the perfect winged attack insect.

Think about the wasp that will attach tarantulas. This professional outdoor aerosol projects a long stream of quick knock-down insecticide, for killing wasps or hornets. Use this product for a quick kill of visible stinging insects as they rest on their nests.

For best results, use Wasp Freeze at dusk when stinging insects are at rest. If necessary, re-apply your wasp spray the following day. The nests of paper wasps are usually located under eaves or other high places where wasp killing aerosols are needed.

Wasp Freeze is designed for quick kill of stinging wasps and hornets, but does not leave a long term residual. If longer residual is desired, use a double-strength solution of Demon WP after using Wasp Freeze insecticide aerosols. If dealing with ground hornets, yellowjackets, or other in-ground nests, you will have poor results using any aerosol or wasp freeze. Always follow the label instructions.



Front and rear sides of a paper wasp's nest.

Bed Bugs

Cimicidae or bed bugs (sometimes bedbugs), are small parasitic insects. The most common type is Cimex lectularius. The term usually refers to species that prefer to feed on human blood. All insects in this family live by feeding exclusively on the blood of warm-blooded animals and humans. I have seen children with a terrible rash and in closer examination, it was bed bug bites and they parent don't care. They need to recognize that they are next and they have it coming. Bed bug treatment is a money maker, but it costs the homeowner much more, because they need to either boil, steam, seal everything in boiling water or throw it away to get these dudes under control. I was at a home that had all new carpet and furniture and the next month they had to replace everything, it's not right to throw good stuff away.

* The typical life span of a bed bug is about 12 to 18 months. Almost impossible to kill in one treatment. It is easier to treat scorpions than bed bugs. Always follow the manufacturer's instructors/label.
* Bed bugs are able to live for several months without feeding on a host. The will live in wall voids, head boards, screw holes, unwashed underwear and mirror backs.
* Female bed bugs can lay up to 300 eggs over their lifetime. They will lay them inside your skin.
* Bed bugs eggs hatch within 2 weeks and takes about another 3 to 10 weeks to reach maturity depending upon the temperature and availability of food. You have to hammer these nasty creatures. It may take three treatments and throwing out everything, furniture, clothes, stuffed toys, beds) in the room to get a hold on the problem,
* Bed bugs are not known to carry disease but their bites can cause allergic reactions in some people. This stuff is spreading like wildfire and it very costly to treat.

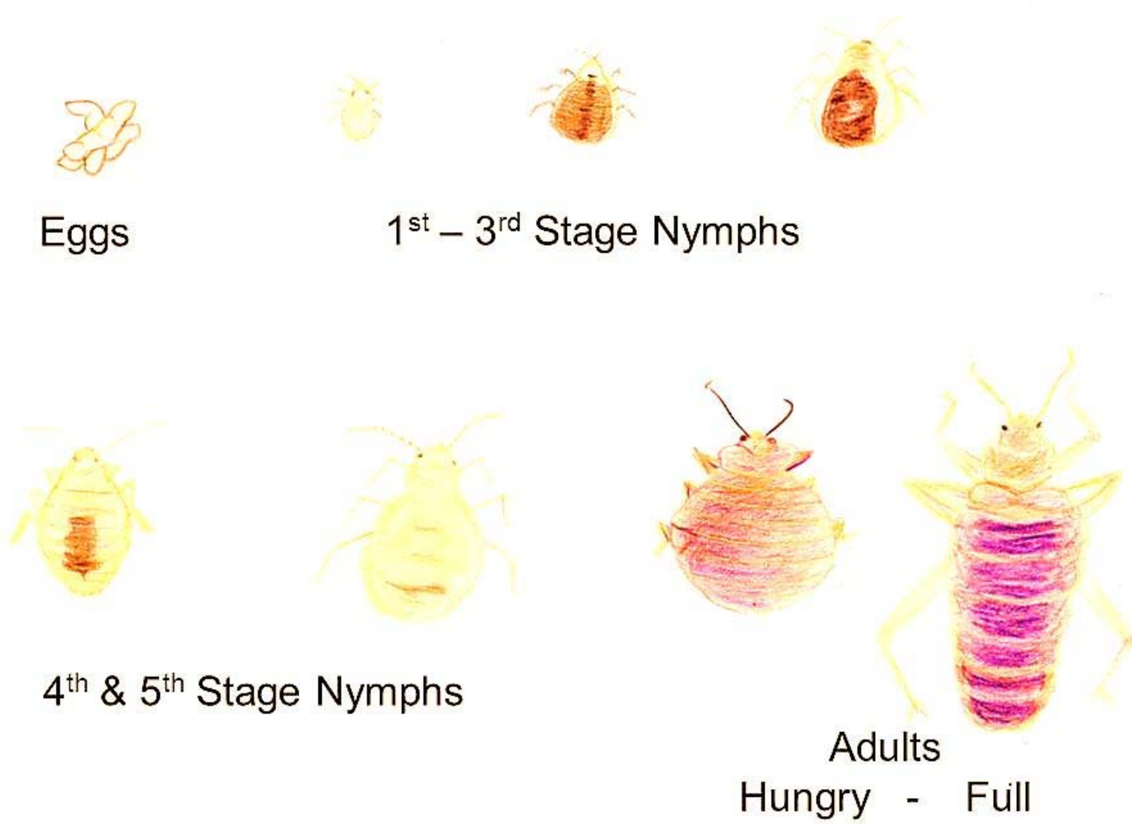
Generally, these nasty bugs are most active at night though they are not strictly nocturnal. I've seen them in the day, but it is rare. Their referred habitat includes infesting beds or other common areas where people may sleep. I have found them in chairs and clothing and the trend is this is getting worse every day.

Adult bed bugs are 1/8 inch long (or the size of an apple seed) and have flat rusty-brown-colored oval shaped bodies. However after feeding on a blood meal, their bodies can swell to a deeper red brown and up to 3/8 inch long. All bed bugs including newly hatched nymphs can be seen with the naked human eye.

Bedbugs have feasted on sleeping humans for thousands of years. After World War II, they were eradicated from most developed nations with the use of DDT. This pesticide has since been banned because it's so toxic to the environment, now there is nothing stopping bed bugs from attacking humans but applicators.

Spurred perhaps by increases in international travel, bedbugs are becoming a problem once again. The risk of encountering bedbugs increases if the customer spends time in places with high turnovers of night-time guests — such as hotels, hospitals or homeless shelters.

Dwellings can become infested with bed bugs in a variety of ways, from:
* Bugs and eggs that "hitchhiked in" on pets, or on clothing and luggage.
* Infested items (such as furniture or clothing) brought in.
* Nearby dwellings or infested items, if there are easy routes (through duct work or false ceilings).
* Wild animals (such as bats or birds).
* People visiting from a source of infestation; bed bugs, like roaches, are transferred by clothing, luggage, or a person's body.



Life Stages
Adult bed bugs are reddish-brown, flattened, oval and wingless. Bed bugs have microscopic hairs that give them a banded appearance. Newly hatched nymphs are translucent, lighter in color and become browner as they molt and reach maturity. Bed bugs may be mistaken for other insects such as booklice and carpet beetles, or vice-versa.

Bed bugs use pheromones and kairomones to communicate regarding nesting locations, feeding and reproduction. The life span of bed bugs varies by species and is also dependent on feeding. Bed bugs can survive a wide range of temperatures and atmospheric compositions. Below 16.1 °C (61.0 °F), adults enter semi-hibernation and can survive longer.

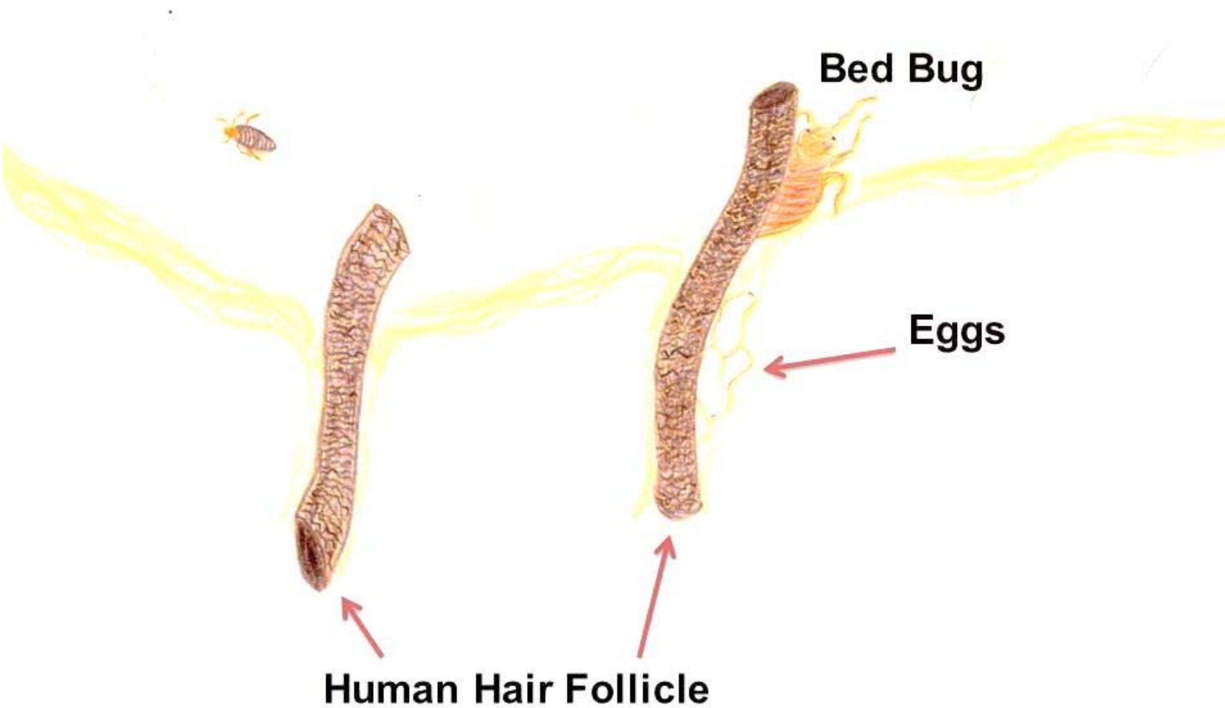
Bed bugs have six life stages (five immature and an adult stage). They will shed their skins through a molting process (ecdysis) throughout multiple stages of their lives. The discarded outer shells look like clear, empty exoskeletons of the bugs themselves. Bed bugs must molt six times before becoming fertile adults.

Dealing with Bed Bugs and Ticks

Step 1 Prepare the Treatment area: Pre-treatment Procedures
* Reduce clutter to make inspection easier.
* Personal items (stuffed animals, soft toys, blankets) should be removed, cleaned with a vacuum cleaner, and bagged in plastic for a couple of days with Nuvan Strips if infestation is severe. You can also bag your laptops, phones, radios in a bag as well. The insecticide in the Nuvan strips will not harm these items and is a non-residual, so you don't have to launder these items after using the Nuvan strips.
* If you dismantle the bed frames, you may expose additional bedbug hiding sites.
* Remove drawers from desks and dressers and turn furniture over, if possible, to inspect and clean all hiding spots.
* Stand up the box spring and shine a flashlight through the gauze fabric to expose bed bugs. If the fabric is torn (possible hiding place), remove fabric to prepare for spraying.
* Caulk and seal all holes where pipes and wires penetrate walls and floor, and fill cracks around baseboards and moldings to further reduce harborages.
* Since infested garments and bed linen can't be treated with insecticide they will need to be laundered in hot water (120°F minimum). If washing is not available, sometimes heating the garments or bed linen for several minutes in clothes dryer may work.
* Thoroughly clean the infested rooms .Scrub infested surfaces with a stiff brush to dislodge eggs.
* Vacuum in area of bed bug harborages with an vacuum attachment. Vacuum along baseboards, nearby furniture, bed stands, rails, headboards, footboards, bed seams, tufts, buttons, edges of the bedding as well as the edges of the carpets(particularly along the tack strips) are key areas to vacuum. A good vacuum cleaning job may remove particles from cracks and crevices to encourage greater insecticide penetration.
* Discard vacuum cleaner bag in a sealed plastic bag when finished.
* Caulk cracks and crevices in the building exterior and also repair or screen openings to exclude birds, bats, and rodents that can serve as alternate hosts for bed bugs.
* Tick dip the dog and cat.

2. Inspect: Look for the Bugs
To inspect well, it may be helpful to briefly understand Bed Bug Diet and Bedbug Habits
Because the bed bugs may be difficult to see with the naked eye, we recommend an industrial powered magnifier and a flashlight.

Look also in your box springs, both top and bottom for any rips that might shelter these bugs.
Inspection Check List:
* Cracks and crevices in head and foot boards, attached side railings and supports
* Inspect mattresses top, sides and bottom. Check all buttons, seams and rips.
* Inspect electrical switch plates, pictures on walls, wall posters
* Inspect cracks in plaster or seams in wall paper.
* Inspect electrical appliances-radios, phones, televisions, etc., looking in hiding places. They hide everywhere and love items we would not consider for normal inspection.
* Inspect tack strips under wall-to-wall carpeting and behind baseboards
* Inspect secondhand beds, bedding, and furniture. The newer better built mattresses do not offer as much shelter and protection for the bed bugs to hide.



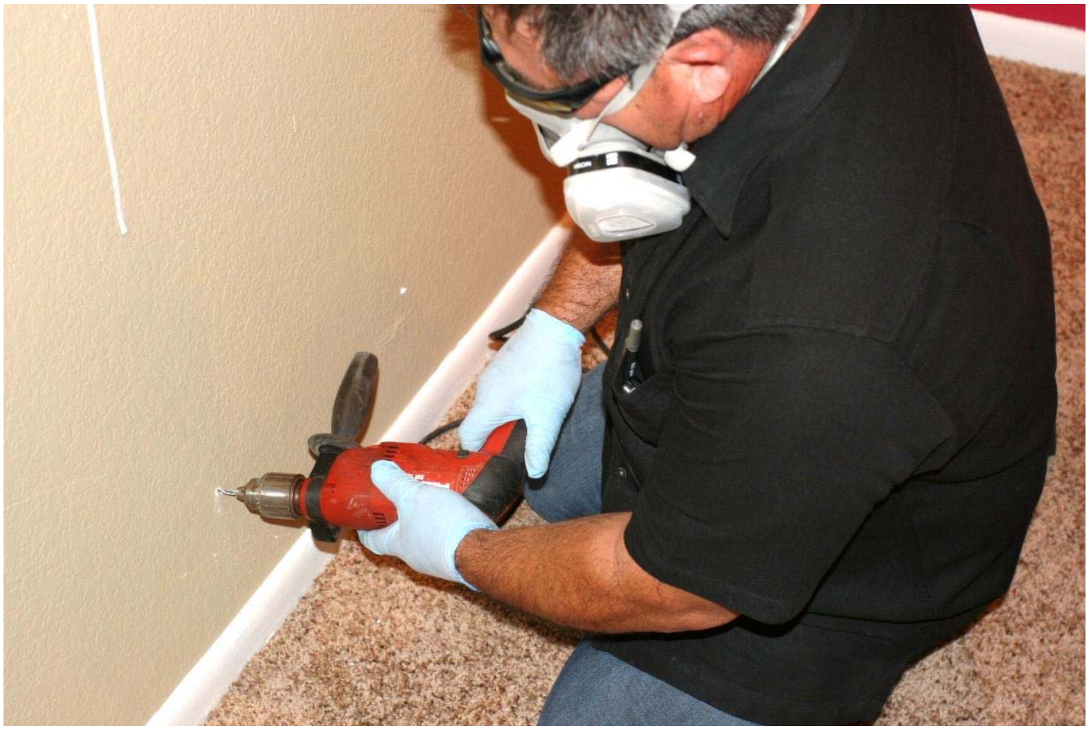
Controlling Infestations
Bed bugs are challenging pests to control. Managing a bed bug infestation is a difficult task that requires removal or treatment of all infested material and follow-up monitoring to ensure the infestation has been eliminated and does not return.

Management will require employing several non-chemical methods such as vacuuming, washing bedding at a high temperature, using steam or heat treatment, and sealing up hiding places.

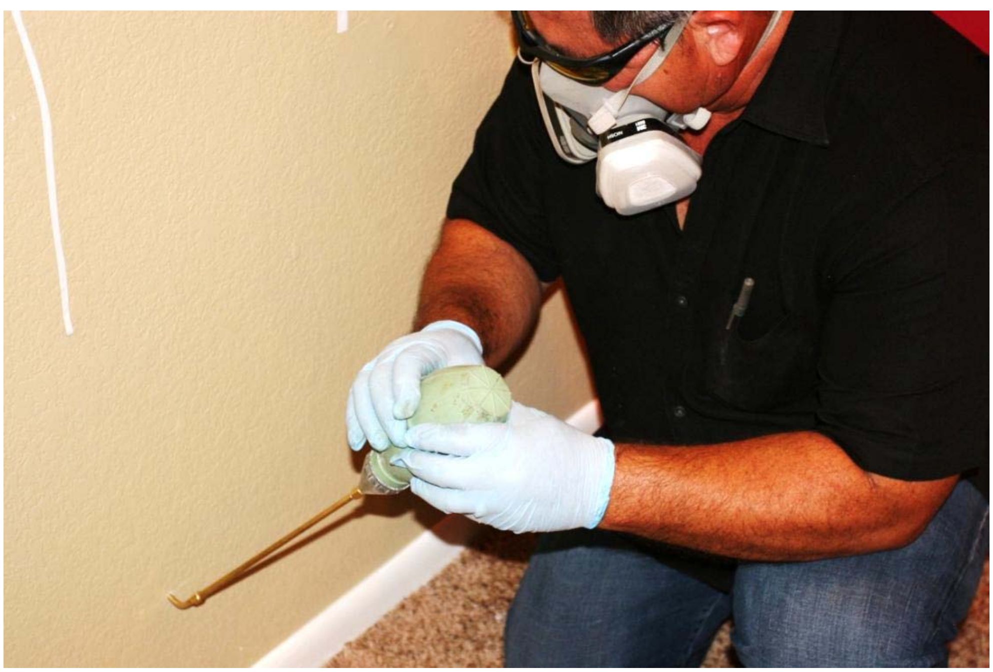
Insecticides may be required to eliminate serious infestations; however few active ingredients are federally registered for bed bugs for over-the-counter use. At the professional control level, there are more registered products; however, resistance among bed bug populations is common, and low-level infestations are difficult to detect. There has been some success combining chemical and nonchemical products with increased sanitation and habitat modification.

Bed bugs hide in many tiny places, so inspections and treatments must be very thorough. In most cases, it will be prudent to enlist the services of a professional pest control firm. Experienced applicators know where to look for bed bugs, and have an assortment of management tools at their disposal. Spray, dust, fog and spray again.

Drill wall voids and dust, spray and fog again. Rip the carpet out, spray, dust and fog again. Always follow the manufacturer's instructions. It is hard to get a hold on these dudes.



Owners and occupants will need to assist the applicator in important ways. Affording access for inspection and treatment is essential, and excess clutter should be removed. In some cases, infested mattresses and box springs will need to be discarded. Since bed bugs can disperse throughout a building, it also may be necessary to inspect adjoining rooms and apartments. I think that fire could not destroy these creatures, these are like cockroaches.



Insecticides may be applied as *liquids* directly to cracks, crevices, bed frames, baseboards, or similar sites or they may be applied as *dusts* in cracks and crevices. Pesticides (depending upon the label and your State) are not generally applied to mattresses or bedding because of risk to people.

***Liquid* insecticide formulations include:**

- Products containing the botanical insecticide pyrethrin, which gives quick knockdown but little long-term control;
- Various synthetic pyrethroid products (cyhalothrin, bifenthrin, deltamethrin, and permethrin); and
- Newer types of products including the pyrrole insecticide chlorfenapyr (Phantom) and the insect growth regulator hydroprene (Gentrol), which cause sterility in adults.

There is growing interest in the last two products, because some bed bug populations have developed resistance to pyrethroid insecticides and no longer can be effectively controlled by them. However, both newer products take up to several days to be effective.

Insecticides applied as dusts cling to the pest's cuticle, wearing away the insect's protective wax covering or poisoning the insect when it grooms itself. Several dust products used in bed bug management include boric acid, diatomaceous earth, fumed silica, and formulations of pyrethroids. These materials can provide long-term control as part of an integrated program if they are placed in out of-the-way places—such as under baseboards or in wall voids—that don't get wet.

Always follow your chemical manufacturer's instructions when mixing or spraying product. Always wear proper PPE and drink lots of water. Take those extra seconds and be safe. These chemicals will slowly kill you as well. Bed bugs are tough to find and harder to kill. I believe a flamethrower would be more helpful at times than a B&G.

Filling your dust blub, always wear a respirator. If not, you are slowly killing yourself as well as Bed Bugs. Below, a unfed adult and the larger Bed Bug is a fed (blood meal) adult ready to mate and lay her eggs in your skin. The cycle starts all over again and again. Some applicators will not use foggers because foggers may spray the Bed Bugs, I say, hammer the Bed Bugs on the return with everything and foggers too.

It is up to your State pesticide agency and/or the pesticide instructions on how and where to apply chemical to furniture. Pesticides (depending upon the label and your State) are not generally applied to mattresses or bedding because of risk to people.

Bed bugs love the seams of fabric and will hide any and everywhere on furniture and in metal fixtures. I have seen hundreds of bed bugs hide in a screw hole or in dirty underwear. I have heard that boiling water will kill bed bugs but I prefer chemical treatment methods. I think we will see a large increase of bed bugs and ticks in the near future. The problem with bed bugs is the return or “call back” treatments.

Spend the extra time on your first treatment, make sure to dust the wall voids and switch plates and behind mirrors. Spray the carpet and always follow the manufacturer’s instructions. Apply heat treatment.

How to treat the mattress with insecticides:
Look carefully at the folds and seams of the mattress, the headboard, foot board (if present), box spring/support platform, frame, headboard, etc. for bedbugs and treat this area after vacuuming.

The following residual insecticides or dusts are labeled to spray or dust mattresses: Always check your State and the label instructions to ensure proper treatment. These suggestions may not work in your area.
* Pyganic Dust
* Bedlam Aerosols
* Temprid SC Insecticide

Dusts lasts longer, but the crack and crevice tips on the Phantom and Bedlams aerosols enable you to get into the smallest cracks. It is a good idea to use both. Temprid SC may be used on the duffs and seams of mattresses as well as a good residual sprayed in other recommended treatment areas such as night stands, chests, dressers, couches and chairs. Always check your State and the label instructions to ensure proper treatment. These suggestions may not work in your area.

Treatment
Treat all baseboards and furniture (Night Stand, Chests, Dressers, Couches and Chairs)
Bed Bug Treatment: Sprays and Dusts. Apply heat treatment for 12-24 hours.

There are several products on the market that work well for bed bugs. Always check your State and the label instructions to ensure proper treatment. These suggestions may not work in your area.

Apply residual liquid, aerosol or dust residual insecticides such as Alpine PT Aerosol (PT Alpine aerosol is effective against insecticide-resistant bed bugs). Cyzmic CS , Temprid SC, Bedlam Insecticide Aerosol, Phantom Aerosol and Pyganic Dust. It is best to use a combination of these products for application purposes. You can get these at discounted rates in be form of kits at Bed Bug Kits. The kits have the residual insecticide with the dust and aerosols.

Cyzmic CS cannot be used on mattresses on boxsprings.
Cyzmic CS Usage: Mix 12 ml.(about 1/2 oz.)(Measurements on the bottle)of Cyzmic CS with one gallon of water(Remember to use what you mix-within 24 hours.) Adjust the spray pattern to a mist by turning the nozzle. A low fine mist is best for most spraying, but you may need to use a stream to get into some cracks and crevices. If you can't get into the cracks and crevices use one of the aerosols described below with its crack and crevice tips to reach into these areas. Always check your State and the label instructions to ensure proper treatment. These suggestions may not work in your area.

Temprid SC can be used on mattresses and boxsprings.
Temprid SC Usage: Mix 8 ml. (about 1/3 oz. measurements on the bottle)of Temprid SC with one gallon of water(Remember to use what you mix-within 24 hours.) Adjust the spray pattern to a mist by turning the nozzle. A low fine mist is best for most spraying, but you may need to use a stream to get into some cracks and crevices. If you can't get into the cracks and crevices use one of the aerosols described below with its crack and crevice tips to reach into these areas. Always check your State and the label instructions to ensure proper treatment. These suggestions may not work in your area.

Temprid SC controls bed bug populations that are resistant to pyrethroid insecticides. For infested mattresses, remove linens and wash before reuse. Apply Temprid to tufts, seams, folds, and edges until moist. Allow to dry before remaking bed. Do not spray bed linens. Apply Temprid SC to bedsprings, box springs, and the interior of bed frames or headboards, including all cracks and joints. Always check your State and the label instructions to ensure proper treatment. These suggestions may not work in your area.

When bed bugs are found in upholstered furniture, apply only to the infested tufts, seams, folds and edges, but do not apply to flat surfaces where prolonged human contact will occur. If bugs heavily infest furniture (inside cushions and/or batting) apply a labeled insecticide dust or consider fumigation.

Apply as a crack and crevice treatment to all baseboards, moldings, beneath floor coverings and carpets, closets, shelves, curtains, furniture and picture frames that may provide harborage to bed bugs.

Re-apply Temprid SC every 7 to 10 days, as needed, until infestation is eliminated.

Aerosols (Alpine PT or Bedlam) Usage: Simply attach the plastic tip to the aerosol can. Apply as a crack and crevice or spot treatment where evidence of bed bugs occurs. This includes bed frames, box springs, inside empty dressers, clothes closets, curtain rods, hollow spaces, carpet edges, high and low wall moldings and wallpaper edges.

Spray liquid insecticides or aerosols:
* Spray around and under the bed and along the baseboards near the bed. After removing the drawers from the furniture, the inside of the cabinetry should be sprayed as well as the bottom and sides of the drawers. Do not treat the inside of the drawers. If needed the clothes in the drawers should be removed and laundered.
* Spray around the inside of the closet, door frame and door.
* Spray molding at top and bottom of room. Spray around windows.
* Spray seams of drawers, both top and bottom. Spray dressers from below. Spray where dressers touch the floor.
* Spray where bed touches floor, spray chairs and underneath chairs.
* Spray all baseboards, loose plaster, behind bed frames and headboards, beneath beds and furniture, and bedsprings and bed frames. Do not apply to furniture surfaces or mattresses where people will be laying or sitting. Infested bedding should not be treated, but should be removed, placed in sealed plastic bags, and taken for laundering and drying at high temperatures. Always check your State and the label instructions to ensure proper treatment. These suggestions may not work in your area.

Dust Usage: (Do not dust on top of moist insecticides)
Put dust into duster. Remove switch plates and electrical outlet covers and dust into the openings. Dust any items hanging on the wall such as pictures with a small paint brush. Use a small paint brush to paint dust in seams and around buttons of mattress.

Use dust or aerosol in all joints of the bed frame. If possible disassemble bed frame and treat from all angles with dust and aerosol. After the mattress and box spring has been treated enclose both of these with Mattress Safe Bed Bug Encasements. With these covers you can keep your bed and do not have to treat it again. Always check your State and the label instructions to ensure proper treatment. These suggestions may not work in your area.

Use a Bulb 4 Oz. Duster to really get into the cracks and crevices with the Pyganic Dust. Another tool used for dusting would be a small paint brush or small makeup brush.

Put a small amount of dust on the tip of the brush, brushing into cracks and crevices.

Important! Do all of the treatments (as described above) 3 times, 10 days apart. Always check your State and the label instructions to ensure proper treatment. These suggestions may not work or be legal in your area.

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.

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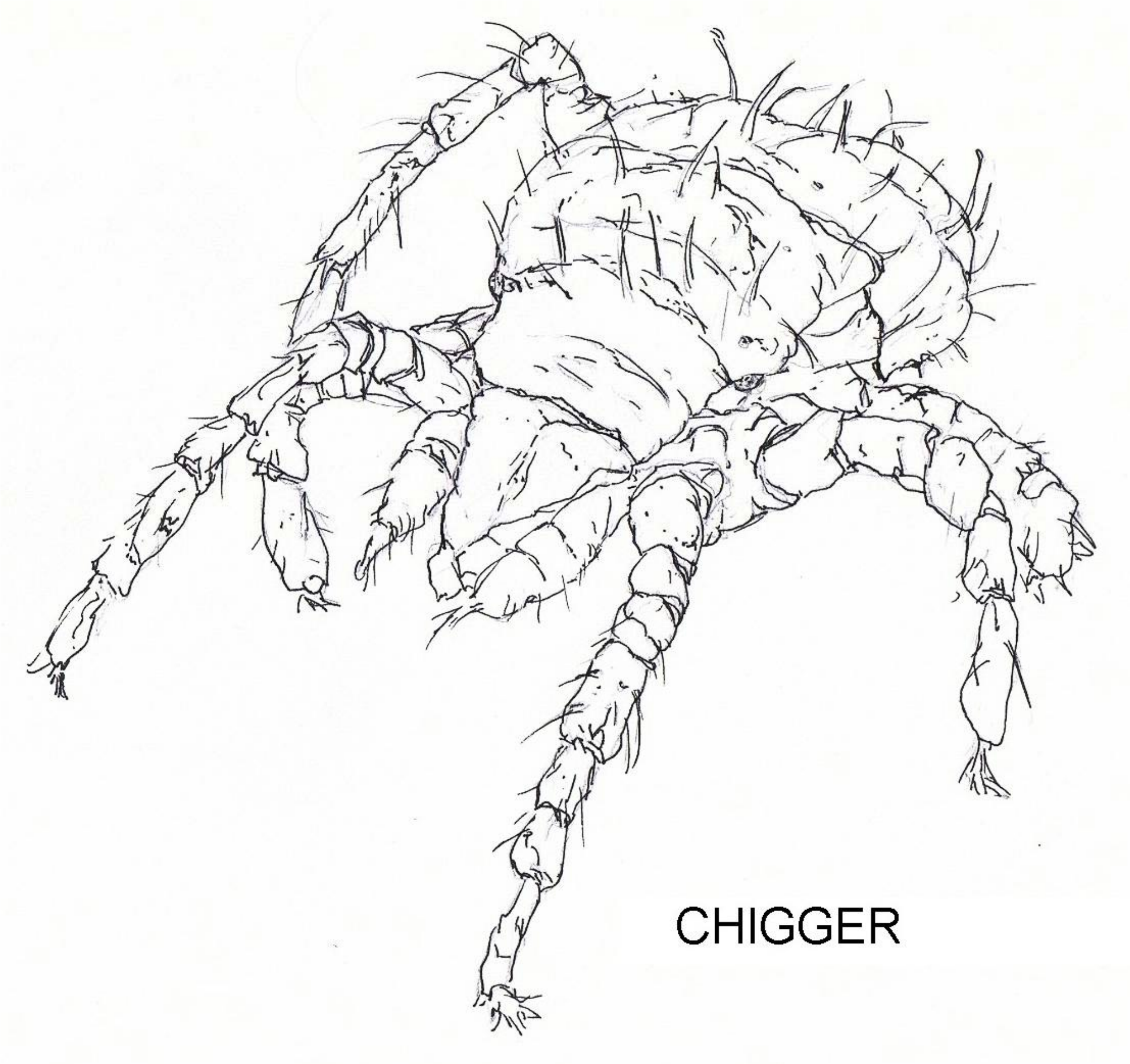


CHIGGER

Pesticide Key Words

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.

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.

Dealates: Winged forms that have shed their wings, like reproductive termites or ants.

Detritivore: Any organism that eats decaying organic matter.

Dimorphic: Having two distinct forms.

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.

Estivation (aestivation): A resting stage (quiescence) resulting from continued high temperature or xeric conditions; diapause; hibernation.

Frass: Solid larval insect excrement; plant fragments made by wood-boring insects, usually mixed with excrement.

Eradication: The complete elimination of either weeds, insects, disease organisms, or other pests from an area.

Fumigant: A chemical that forms vapors (gases) which are used to destroy weeds, plant pathogens, insects or other pests.

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.

Microbial Pesticide: Bacteria, viruses, fungi and other microorganisms used to destroy or control pests.

Pedipalps: Second pair of appendages of the cephalothorax corresponding to the mandibles of insects.

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.

Pupal stage (pupa): The stage in complete metamorphosis between larva and adult like the cocoon in moths.

Pesticide: A chemical or other agent used to kill or otherwise control pests.

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.

Ant Section

Introduction

All ants live in colonies, which consist of an egg-laying female (queen), short-lived males, and workers (sterile females). The ants you see foraging in your garden or kitchen are workers. Workers that find food communicate with other workers by depositing a chemical message on the substrate as they crawl back to the nest.

Although we cannot smell it, this "*trail pheromone*" sticks to the substrate for long periods of time and helps other ants find the food at the end of the trail. In the spring, ants develop wings and fly to new locations and invade homes to forage for food or to establish a new nest.

Ants are a major annoyance to homeowners and are difficult to control. You should not underestimate the importance of good sanitation to eliminate food sources, although good sanitation may not control an ant infestation by itself.

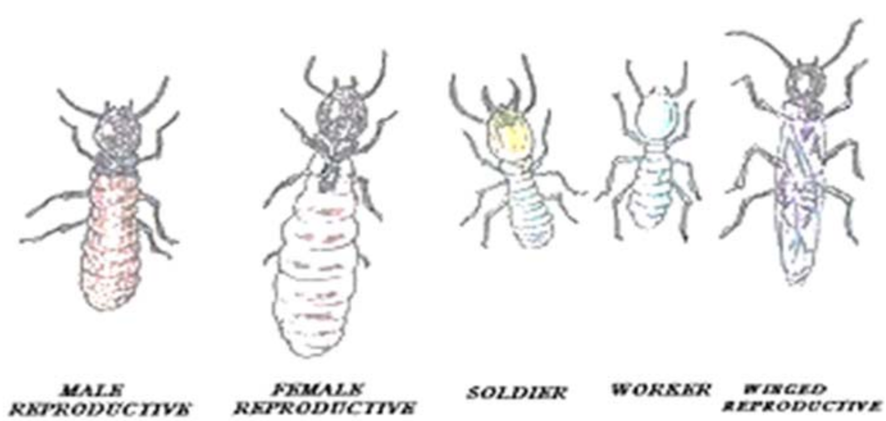
Although we do not like sharing our homes with ants, they are beneficial organisms in the balance of nature. In nature, ants greatly reduce the amount of dead and decaying plant and animal organic matter. They also aerate the soil with their nests. Many ant species have a fondness for honeydew that aphids produce from feeding on plants. Large numbers of ants crawling on a plant may be a sign of serious aphid infestation.

Ant infestations are not easy to control and different strategies should be used depending on nest location and food preferences of the ants. Ants can be controlled with a combination of good sanitation, removing pheromone trails, caulking entry points, and eliminating active nests. Insecticide sprays and baits can be used to kill foraging ants and destroy nests, but strategies designed to prevent further infestations should be used in conjunction with chemical treatment.

Termites

Termites also develop wings and swarm during the spring and look similar to flying ants. Examine them closely to make sure that you have the correct pest! Ants are thin-waisted and have elbowed antennae. Termites have thicker waists and have antennae that resemble strings of tiny beads. You may need a magnifying glass to examine antennal features.

As a group, ants have a wide food range, feeding on sweet foods, greasy materials, starchy substances, wood, and all kinds of plant and animal materials. Part of the reason that ants become a nuisance in our homes is that they often like the same kinds of food that we do.



Ant Control
There are two categories of ants that will be encountered with an ant problem. The best control strategy depends on the type of infestation. Ants that live outside will travel inside the home to search for food. Some species may ultimately reside in houses, discussed later in this section. To prevent both of these scenarios, follow these procedures:

First, cracks and crevices should be sealed to eliminate passages into the home. If you do not seal entry points, ants will probably find their way into your house at some later time.

Second, scrub around entry points with a detergent (to remove the trail pheromone) and spray a residual insecticide around entry points. Bait treatments and insecticides can be used to control ants in the outside nest. To be effective, baits must be placed in areas where ants frequent, be eaten, and be taken back to the nest. There are several different kinds of baits available, and you may have to do a little trial-and-error to find the proper bait.

Because the ants must get back to the nest for satisfactory control, this strategy may be incompatible with insecticide sprays, which may kill worker ants before they can get back to the nest with the bait. The successful use of a bait may take several weeks or more. Insecticide dilutions can be used outside to successfully drench ant nests. Be sure to follow label recommendations for correct procedures when applying the insecticide.

There are some types of ants that actually establish a nest inside your home, instead of merely entering to forage for food and returning outdoors. Ants in this category may be present year round, although they will be more active in the warmer months. Ant species that may live in United States homes include *crazy ants, odorous house ants, pavement ants, pharaoh ants, thief ants, and carpenter ants*.

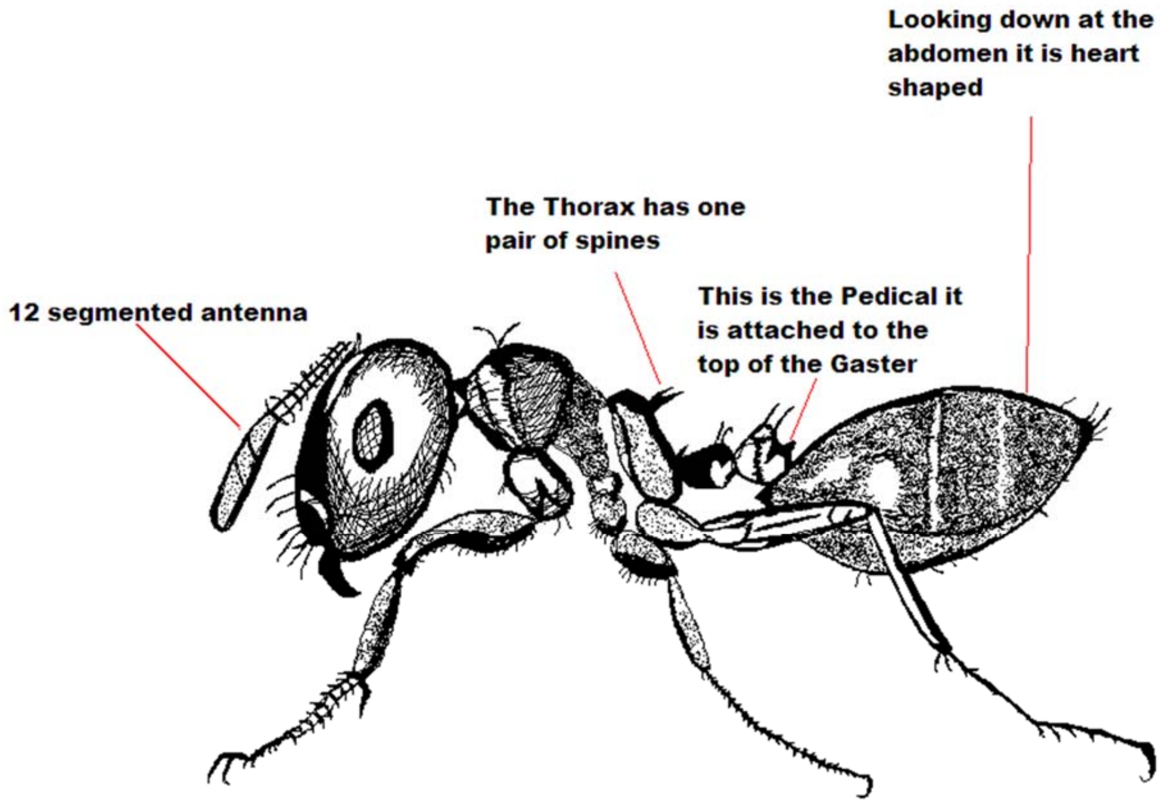
All of these ants may infest food products. Spraying a residual insecticide to control foraging workers may provide only short-term control. Even when over 99 percent of foraging workers are killed by insecticide sprays, the colony may rebuild to its original numbers. Location and total destruction of the nest is the most direct way to eliminate this ant infestation.

Ant baits, described above, can again be a useful tool in eradicating inside-the-home ant nests, although baits may not work as well with carpenter ants as with the other species mentioned. Again, workers must eat the bait, take it back to the nest, and feed it to the queen and larval ants. This type of control is incompatible with treatments that prevent workers from returning to the nest with the bait.

IPM Control Program
An Integrated Pest Management (IPM) approach offers a greater chance for control of ants. An IPM approach incorporates all available control methods into a pest management program. IPM methods include identification, inspection, sanitation, exclusion, and chemical strategies.

Collection Tip
One way to collect ants for identification is to place a dab of honey or sugar water in the center of an index card. Place the index card covered in ants into a plastic bag, then place the bag in the freezer. The cold temperatures will slow the ants down or kill them. When they are immobilized, the ants can be easily tapped into a vial of alcohol and submitted for identification.

Various Ants and Ant Control Methods Section



The **Acrobat Ant**, *Crematogaster sp*., nests under stones, in stumps, or dead wood, and occasionally invades the home. These ants have a heart-shaped abdomen that is often held up over their bodies. They feed primarily on honeydew produced by aphids. Acrobat ants get their name from their unique habit of sometimes running while holding their abdomen above their thorax when disturbed. This gives them the appearance of an acrobat who walks on his or her hands.

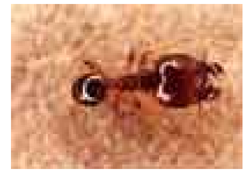
These ants do not build large, above ground mounds. Instead, they are more likely to be found nesting in dead tree limbs, hollow logs, fallen trees, old tree stumps, or even the hollow cavity of a tree.

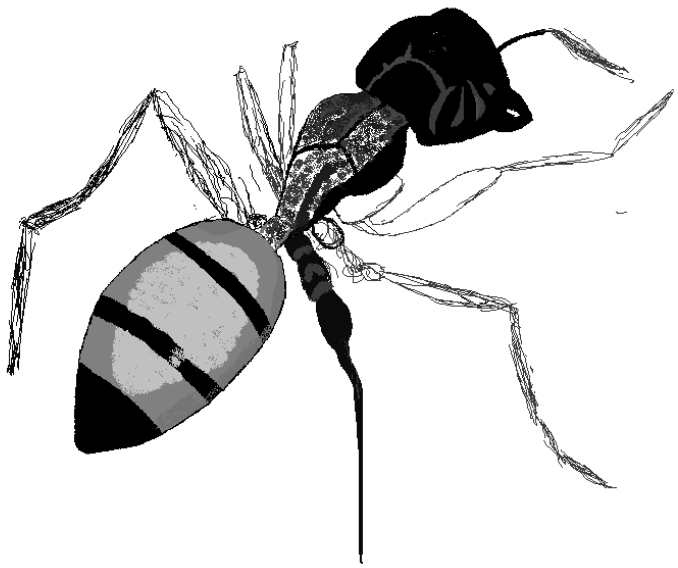
Around a home or business, acrobat ant colonies can be found in any organic litter or mulch and beneath stacks of firewood, under stepping stones, landscape timbers, bird baths, etc. They are often found in shrubs or ornamentals, feeding on insects and the honeydew produced by aphids. All of these areas must be taken into consideration when eliminating acrobat ant infestations.

Worker ants enter a homes or other structure by crawling along electrical and phone lines. They also access homes from shrubs or trees that are too close to or touching the building or by simply crawling up the outside walls to enter around windows, doors, cracks, crevices, or through vents. It would be very difficult (if not impossible) to eliminate all access points.

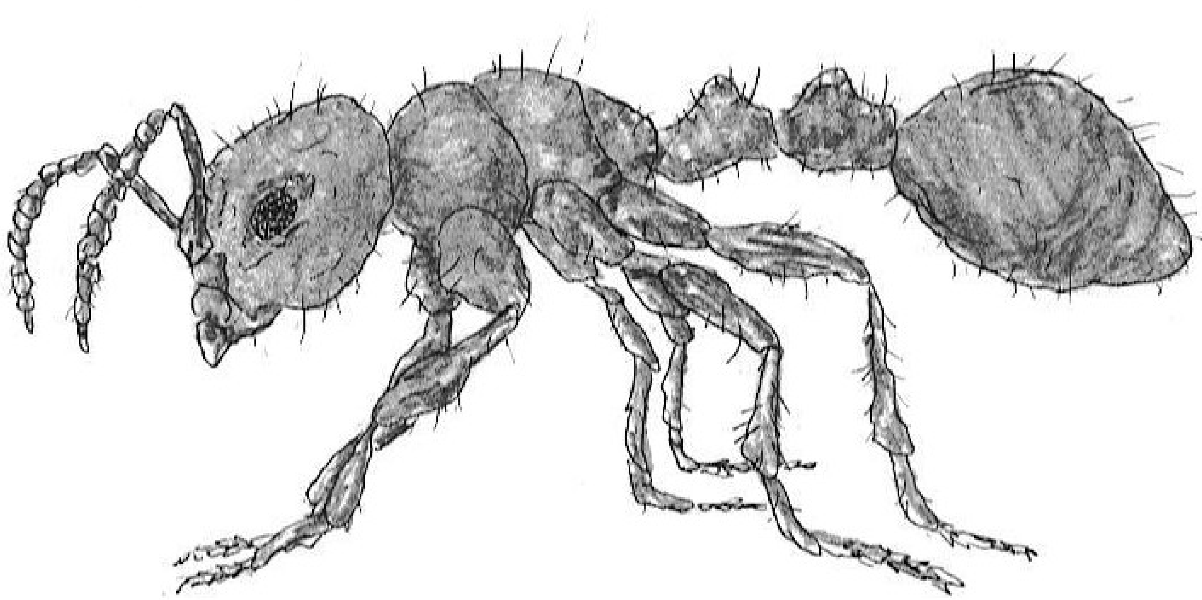
The **Argentine Ant**, *Iridomyrmex humilus* (Mayr), workers are light to dark brown and generally nest outdoors. It is not common in areas infested by the red imported fire ant. More about this ant later in this course.

The **Bigheaded Ant**, *Pheidole megacephala* (Fabricius). Worker ants have relatively large heads compared to their bodies. They have a 12-segmented antenna and 3-segmented clubs. Their habits are similar to red imported fire ants, feeding on live and dead insects, seeds, and honeydew outdoors, and greasy food sources and sweets indoors.



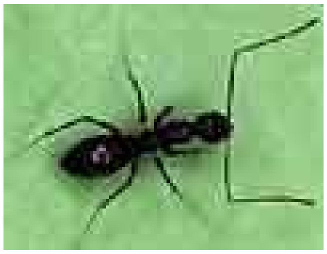


Top drawing, Carpenter Ant; below, Odorous House Ant or Piss Ant.



Crazy Ant

Workers of the **Crazy Ant**, *Paratrechina longicornis*, are fast-running, grayish black ants with long legs and antennae. They nest primarily outdoors, but they will forage in homes. Although they are omnivorous, they are difficult to attract to ant baits.




Crazy Ant **Black Ant** **Pavement Ant**

Black Ant

The little Black Ant, *Monomorium minimum*, is a slow-moving, small black ant that is generally not a pest indoors. Workers prey on insects and feed on honeydew produced by sucking-types of insects, such as aphids. The little black ant is versatile, nesting both indoors and outdoors. The ants prefer decayed woods, but will build nests in any woodwork voids or cracks in cement. Outdoor colonies are found under stones/rocks, in rotting logs, in lawns, or in open areas. Nests can be located by the small craters of fine soil which are deposited at their entrances.

Foraging and Feeding of the Black Ant

The workers forage in scent marked trails along the edges of structures such as foundation walls and along sidewalks outside. They feed on aphids as a source of honeydew, plant secretions and are predaceous on other insects. In the home, the little black ant will feed on almost any food items it can find, such as grease, oil, meats, sweets, fruits and vegetable materials such as corn meal.

The little black is native to the United States and can be found throughout the country. They are most populous in the eastern half of the U.S., in southern California, and in the bay area of San Francisco.

Pavement Ant

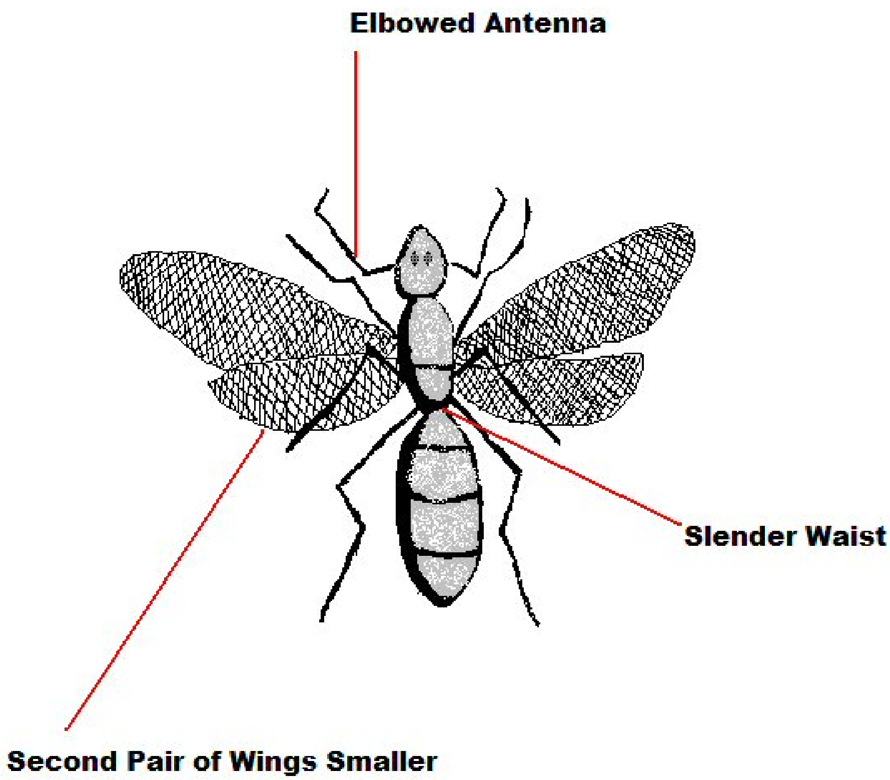
Workers of the Pavement Ant, *Tetramorium caespitum* (Linnaeus), also resemble the fire ant, but on close examination, the head and thorax are roughened with parallel grooves, rather than being smooth.

Control

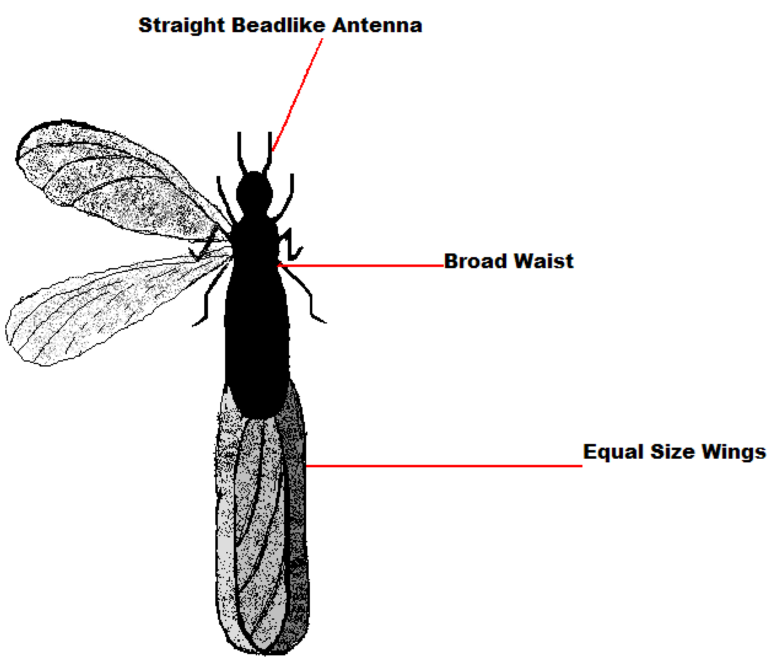
To avoid further infestations indoors, all cracks and gaps in exterior walls should be sealed. To limit the nesting of ants surrounding the dwelling, all debris should be removed and firewood stored off the ground. Their foraging trails can be followed back from the food source to the nest.

Infested interior walls and voids in the outside ground-floor walls may be treated by aerosol injection of a suitable insecticide (CB-80, CB-Invader, CB-Strikeforce) or by an application of a dust formulation (Delta Dust). Baiting, however, may also be necessary.

Baits should be positioned where ant trails have been established. Sweet baits are generally the most effective; however, if acceptance is low, a protein-based bait may be considered.



Winged Ant



Winged Termite

Carpenter Ants

Carpenter ants are usually larger than most other house- infesting ants. They vary in color from a dull black or reddish yellow color to a combination of black and dull red or reddish-orange. Worker ants range in size from 5/16 to 7/16 inches long. Carpenter ants tunnel into wood to form nest galleries. If they go unnoticed for several years, they may cause structural damage. Outdoors, the ants use dead trees or tree limbs, stumps, logs or areas under stones as nesting sites.

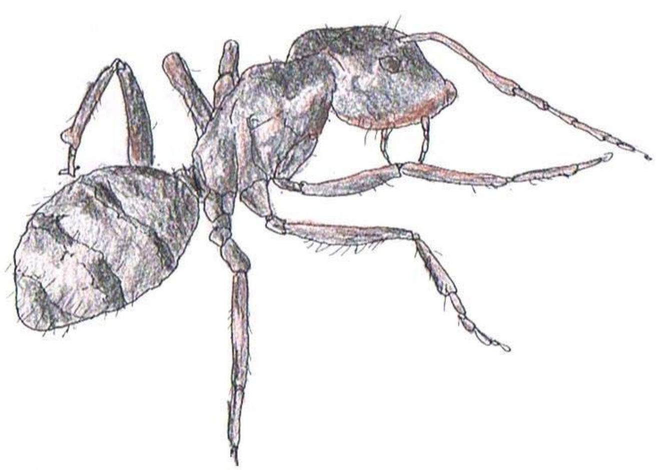
Once the carpenter ant nest has been located, control is relatively easy. Treatment options include use of a bait or residual contact insecticide applied as a dust or spray to the nest. Read and follow the product label for best results. It may be necessary to drill small holes in the wall voids, baseboards, and window and door sills to reach the nest or major part of the colony. Nests can also be removed and infested wood replaced, if feasible.

Carpenter ants are most active in the evening hours, foraging for all kinds of food, both inside the house and outside. By following the ants, you may be able to tell where the nest is. Because carpenter ants keep the tunneled galleries very clean and push the sawdust and dead insect parts out small holes in the wood, a small, fresh pile of sawdust under the nest timber is the usual sign of an active carpenter ant nest.

Once a nest is found, treatment is usually easy with either an insecticide dust or spray. Injection of insecticide into wall voids or the nest itself may be necessary to reinsure complete control.

To prevent further carpenter ant infestations, trim all trees and bushes so branches do not touch the house and correct moisture problems such as leaky roofs and plumbing. Paint and/or seal exposed wood construction before it becomes wet. Replace previously ant-infested wood, rotted or water-damaged wooden parts of the structure and eliminate wood/soil contacts. Remove dead stumps on the property and store firewood off the ground and away from the structure.

Unlike other home-inhabiting ants, carpenter ants cause structural damage to wood by tunneling and nesting inside wood structures. However, they rarely nest in sound wood, but consistently invade wood that has become wet and started to decay.



BLACK CARPENTER ANT

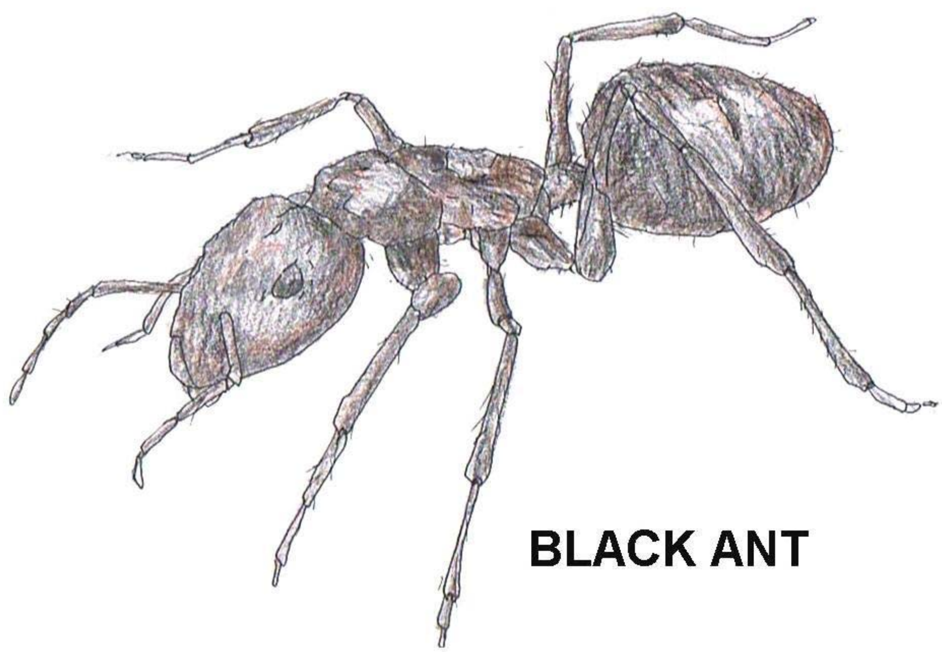
Carpenter ants are large (about 3/8” to 1/2" long) and black or red.

The best way to control carpenter ants that inhabit a dwelling is to find the nest and destroy it. Insecticide sprays inside the home will kill some of the worker ants, but unless the entire nest is treated, the queen will continue to produce additional members of the colony. Locating a nest can be difficult because nests may be in locations within the walls or roof rafters. At this point, some homeowners may prefer to work with a professional pest control company. The most likely places to find carpenter ant nests are where wood has been wet and weathered, such as rotting timbers about the foundation, window sills, porches, around leaky plumbing, and in rafters under a leaky roof.

Perimeter Insecticide Treatments

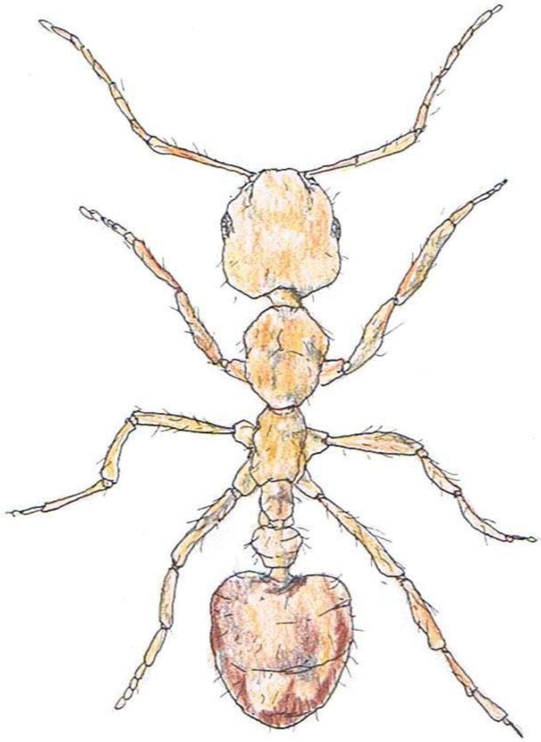
The most commonly used method for controlling carpenter ants is treating the perimeter of a home with a dust or spray. There are several products available for this type of application, but Suspend SC, Talstar Concentrate and Cynoff WP are the best. When used in accordance with their labels they work well.

However, these treatments do not keep ants from entering a home from overhead trees and power lines. Also, as a stand-alone treatment, they rarely eliminate ants inside voids and walls.

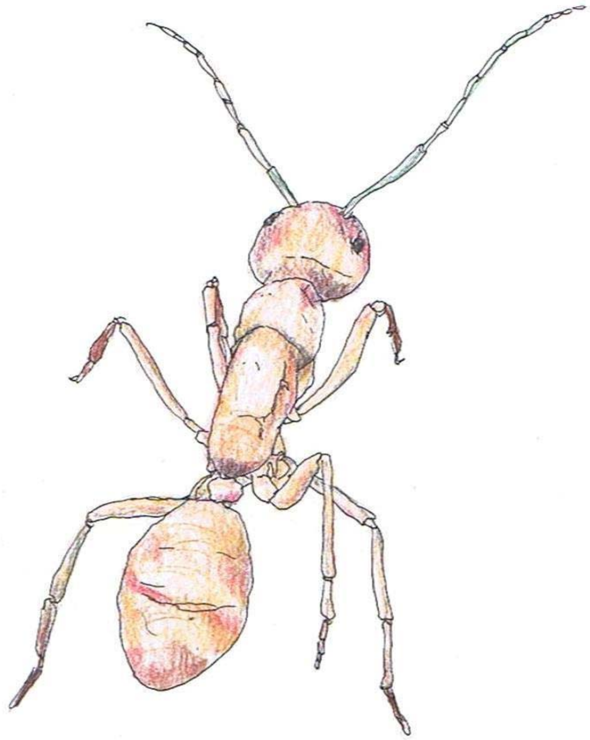


BLACK ANT

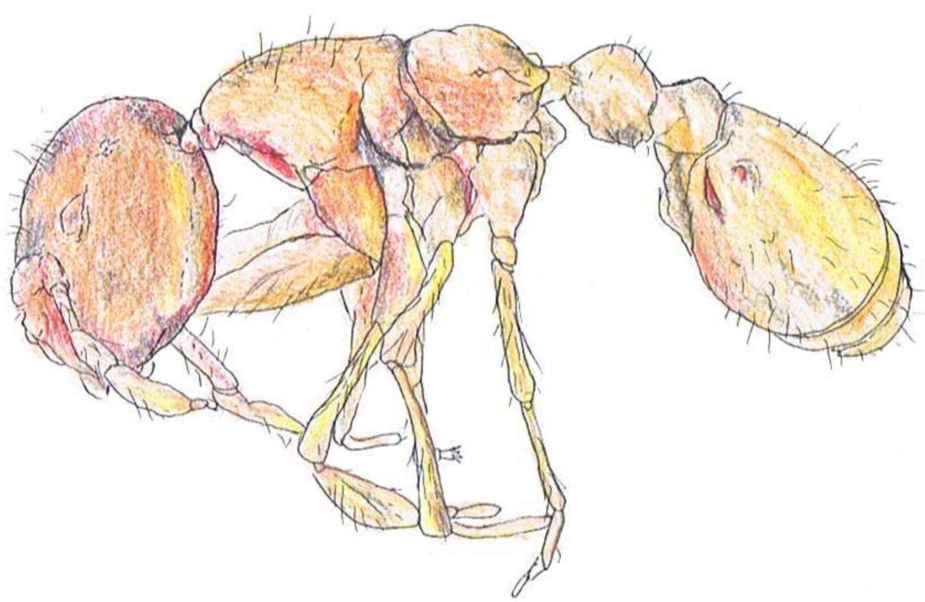
This course contains EPA’s federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA’s regulations and these are frequently changed. Check with your state environmental/pesticide agency for more information.



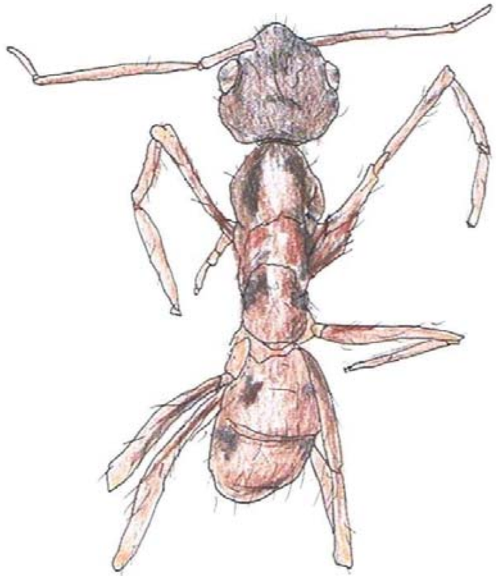
PHAROAH ANT



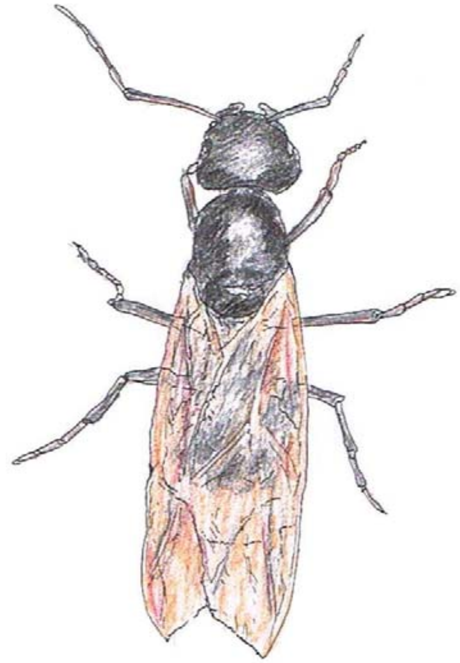
YELLOW ANT



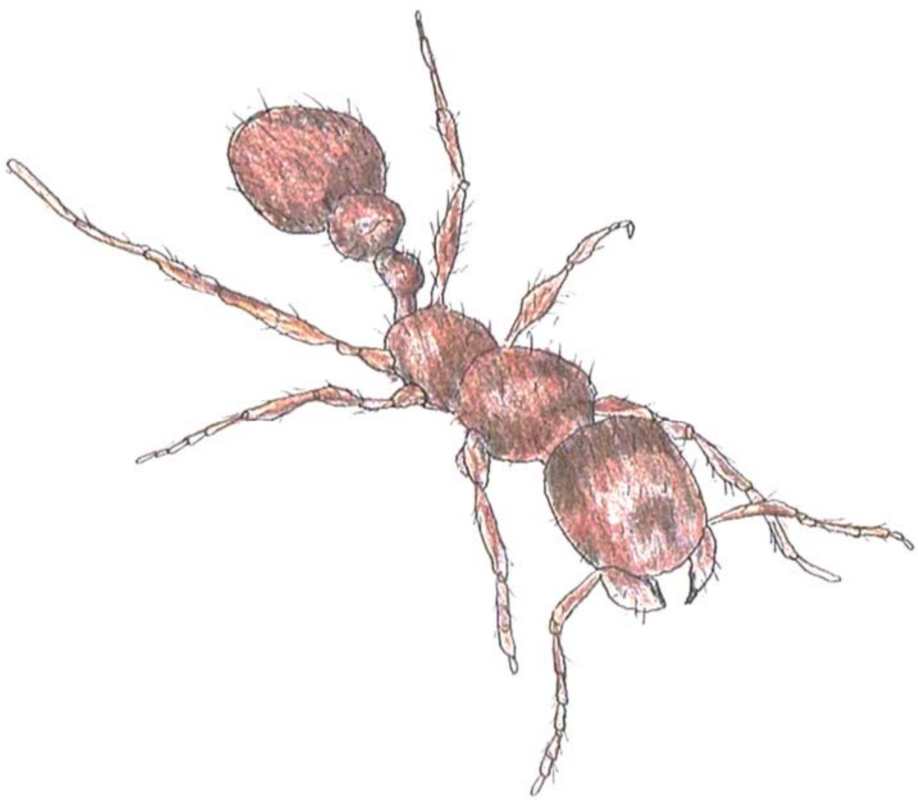
THIEF ANT



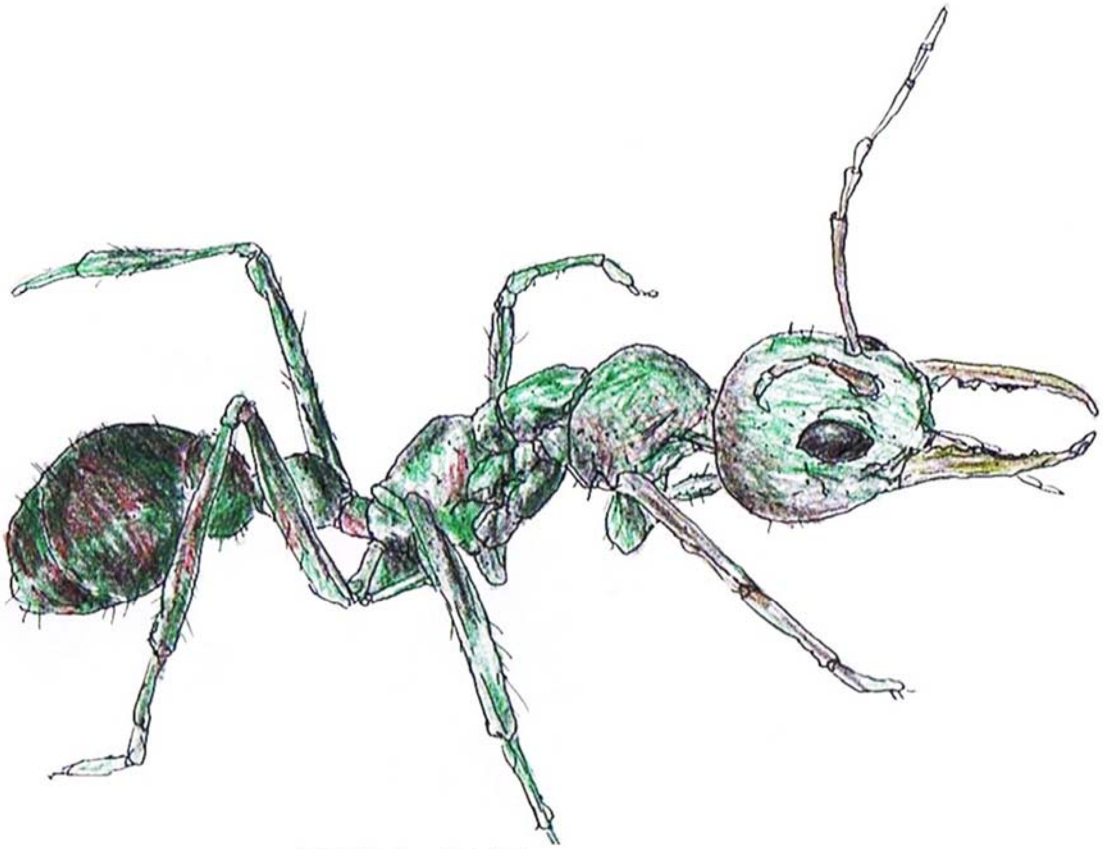
CRAZY ANT



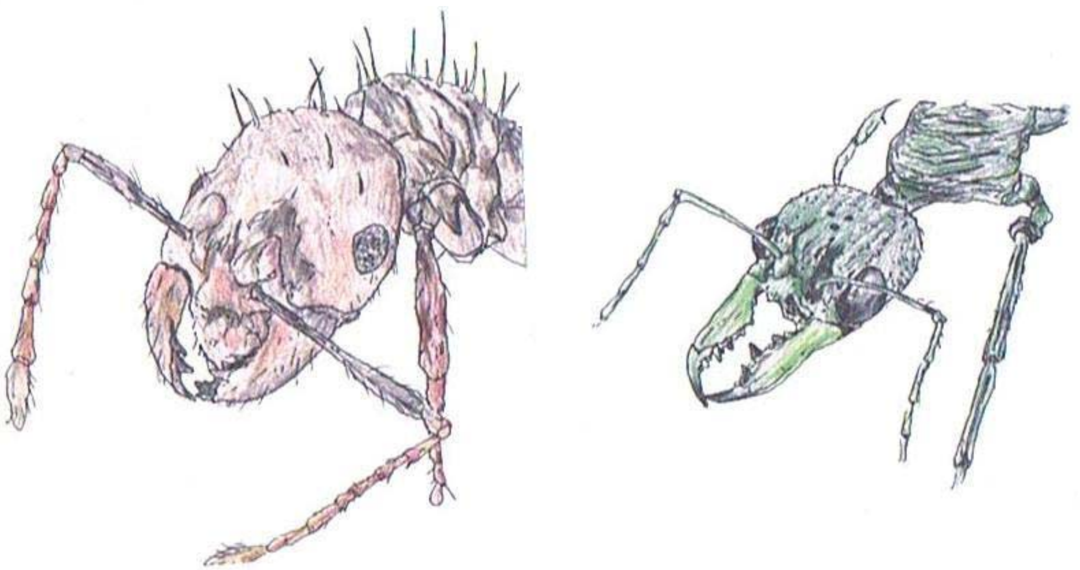
BLACK CARPENTER ANT (QUEEN)



PAVEMENT ANT



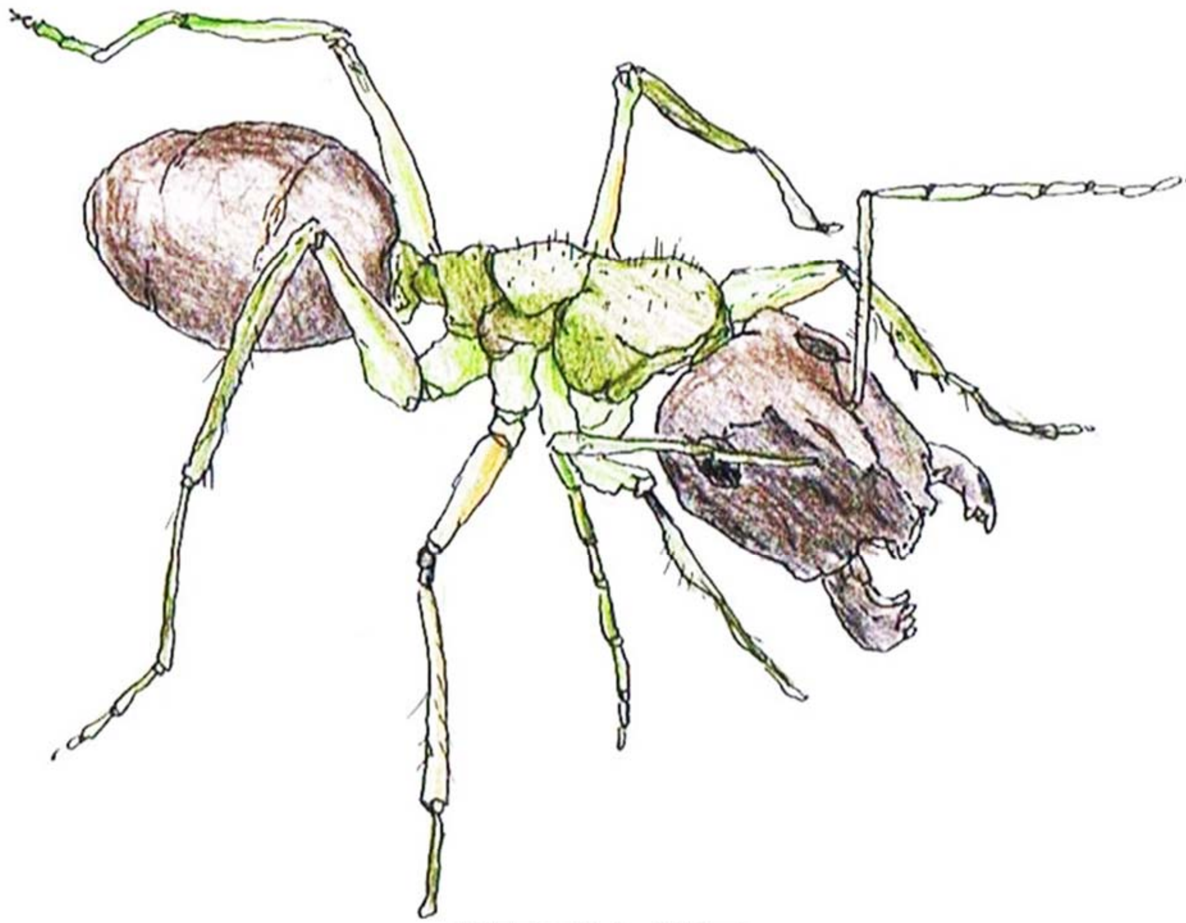
BULL ANT



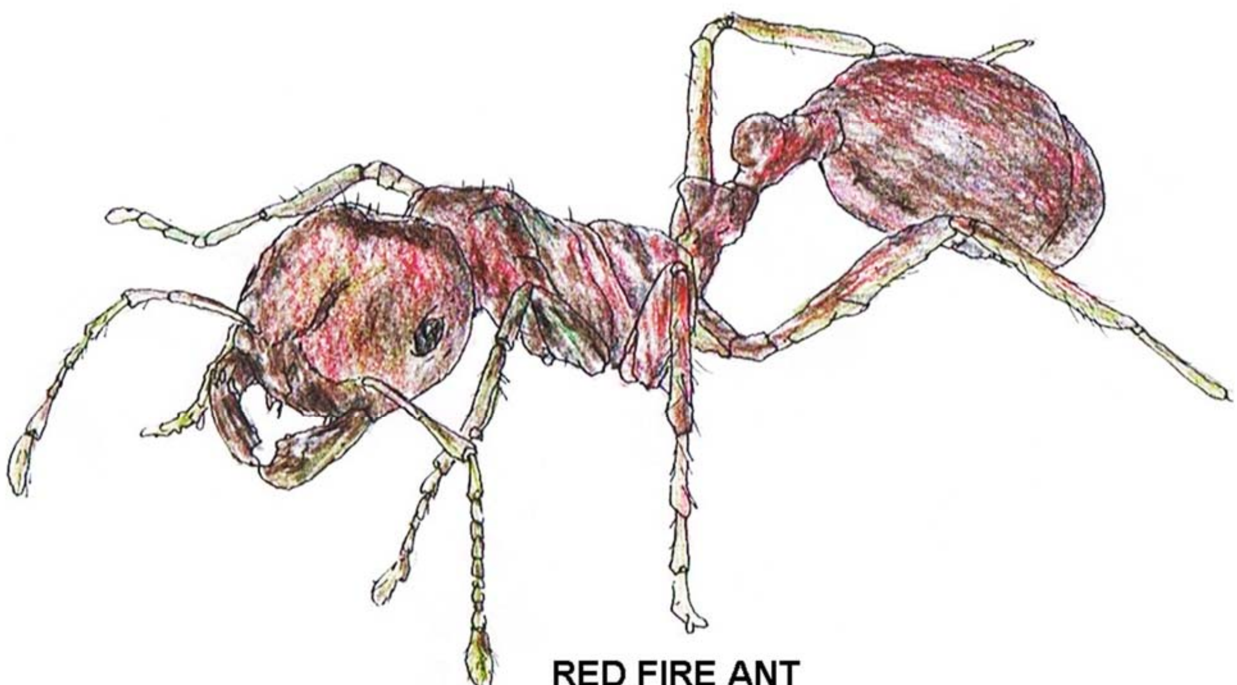
FIRE ANT

BULL ANT

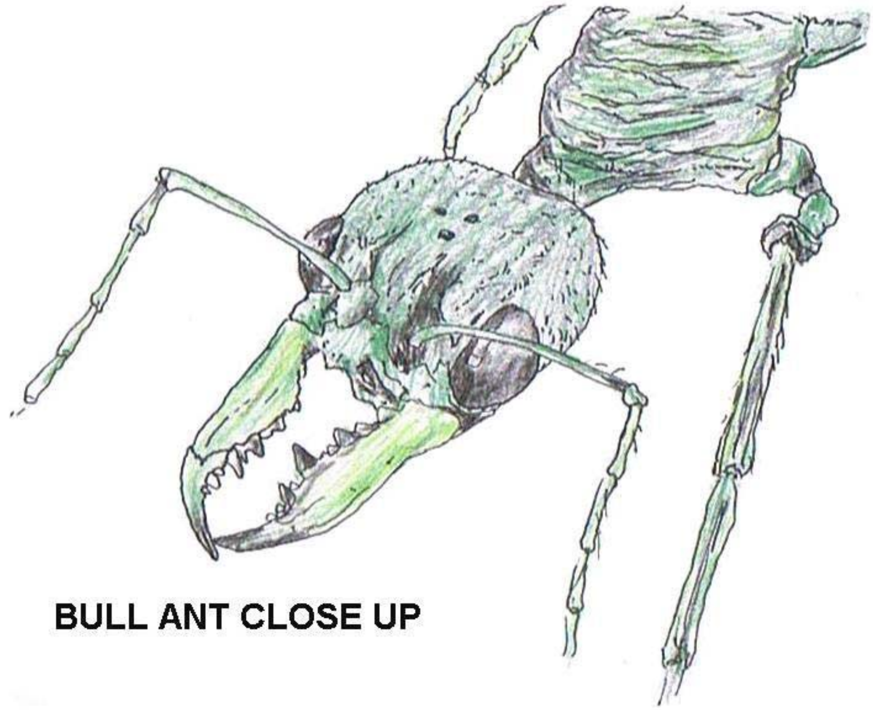
CLOSE-UP COMPARISON OF THE FIRE AND BULL ANT



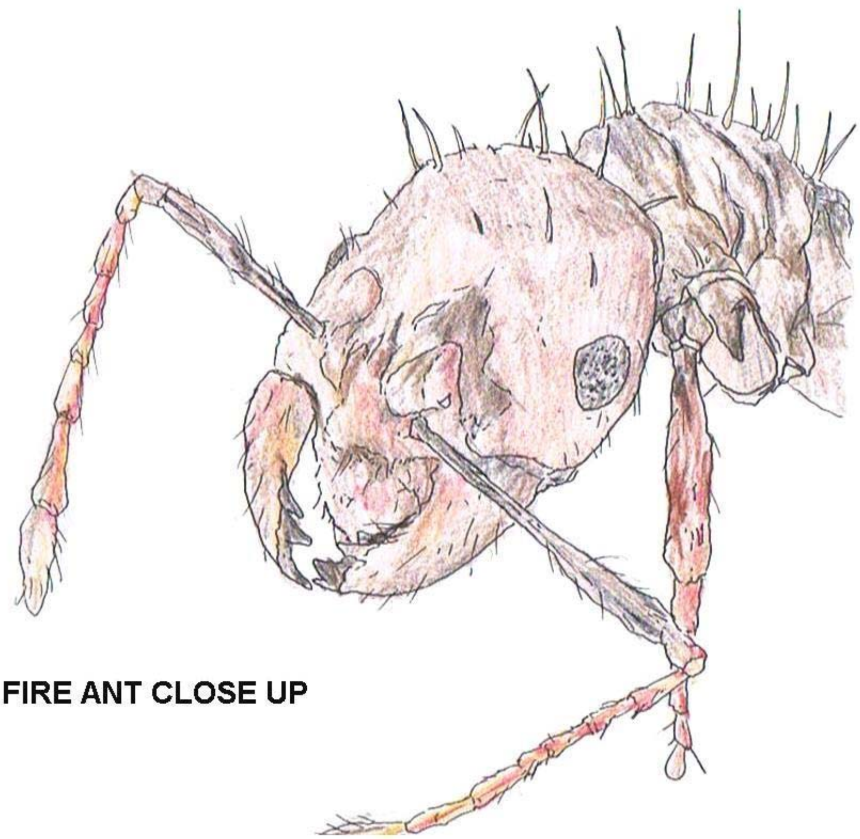
SUGAR ANT



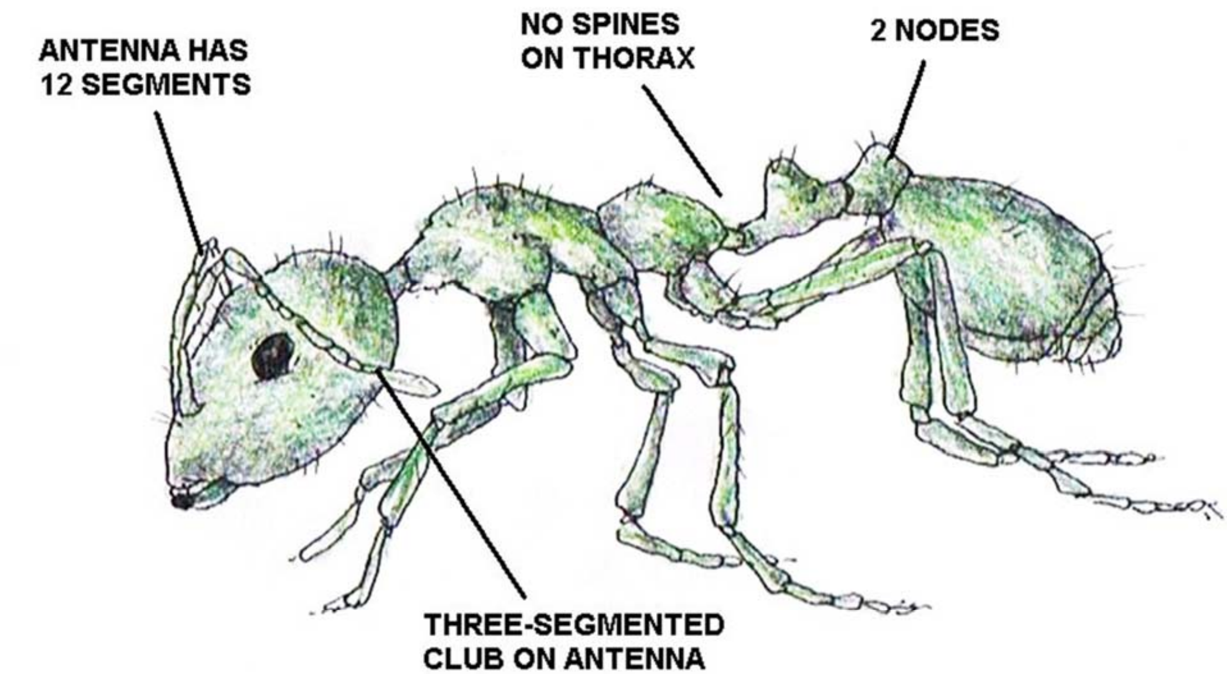
RED FIRE ANT



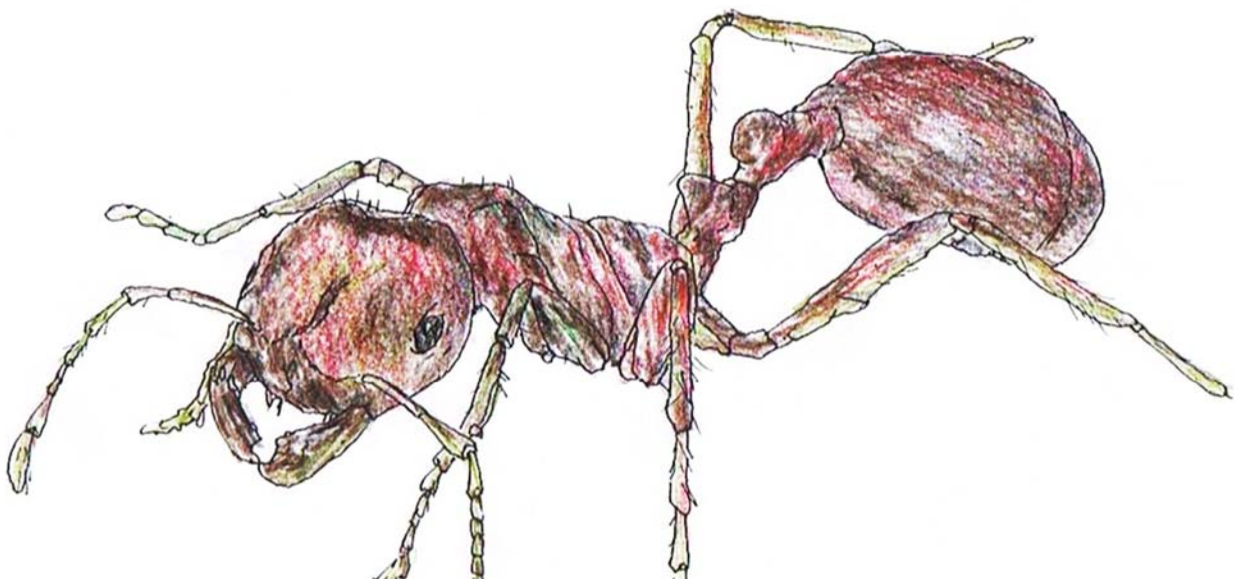
BULL ANT CLOSE UP



FIRE ANT CLOSE UP



LITTLE BLACK ANT



RED FIRE ANT

Pharaoh Ant *Monomorium pharaonis*

Order: Hymenoptera

Identification
Pharaoh workers are very small (about 1/16-inch long); light yellow to reddish brown in color, with the abdomen (hind portion of body) somewhat darker. There is no stinger. The petiole (narrow waist between the thorax and abdomen) has two nodes and the thorax has no spines. Eyes are well-developed. The antennal segments end in a distinct club with three progressively longer segments. This is in contrast to the thief ant's 2-segmented club.

Pest Status
Very common throughout the U.S. and the most commonly occurring indoor ant; in hospitals, it can be a carrier of more than a dozen pathogenic bacteria, including Staphylococcus, Salmonella, Pseudomonas, and Clostridium; these ants do not sting and usually do not bite.

Life Cycle and Habits
Description: Also called the sugar ant, odorous or piss ant, these are some of the smallest ants, the workers are about 1/12-16 inch long, with a light tan to reddish body. Over 200 species of ants are known to exist in the U.S. A number of other ant species are occasionally encountered in and around the home.

Winged stage

Life Cycle
Development of worker ants progresses from eggs (5-6 days), to several larval stages (22-24 days), pre-pupal stage (2 to 3 days), a pupae (9-12 days), and adult ants, thus taking from 38 to 45 days from egg to adult (4 days longer for sexual forms).

Colonies consist of one to several hundred queen ants, sterile female worker ants, periodically produced winged male and female reproductive ants (sexuals), and brood (developmental stages). These ants do not swarm. Colonies multiply by "*budding*", whereby a large part of an existing colony migrates, and carrying brood to a new nesting site.

Female Pharaoh
A Female Pharaoh ant can lay 400 or more eggs in her lifetime. Most lay 10 to 12 eggs per batch in the early days of egg production and only 4 to 7 eggs per batch later. At 80°F and 80 percent relative humidity, eggs hatch in 5 to 7 days. The larval period is 18 to 19 days, prepupal period three days and pupal period nine days. About four more days are required to produce sexual female and male forms. The entire life cycle takes about 38 to 45 days depending on temperature and relative humidity. Unlike most ants, they breed continuously throughout the year in heated buildings and mating occurs in the nest. A single queen can produce many hundreds of workers in a few months. Mature colonies contain several queens, winged males, sterile females or workers, eggs, larvae, pre-pupae, and pupae growing to as large as 300,000 or more members.

Periodically a queen, together with a few workers carrying immatures (eggs, larvae, and pupae), leaves the nest and sets up a new colony elsewhere, quickly spreading an infestation. This behavior pattern is known as "*satelliting*," "*fractionating*" or "*budding*" where part of the colony migrates to a new location rather than by single females dispersing after a reproductive swarm. Budding may occur due to overcrowding, seasonal changes in the building's central heating and cooling system, or application of a repellent pesticide.

Nests are often so small they can be contained in a thimble, located between sheets of paper, in clothing or laundry, furniture, foods, etc. Nests usually occur in wall voids, under floors, behind baseboards, in trash containers, under stones, in cement or stone wall voids, in linens, light fixtures, etc. They prefer dark, warm areas near hot water pipes and heating tapes, in bathrooms, kitchens, intensive care units, operating rooms, etc. They are "*trail-making*" ants and often are found foraging in drains, toilets, washbasins, bedpans, and other unsanitary sites, as well as in sealed packs of sterile dressing, intravenous drip systems, on surgical wounds, food, and medical equipment.

Habitat, Food Source(s), Damage
Mouthparts are for chewing. Pharaoh ants are omnivorous, feeding on sweets (jelly, particularly mint apple jelly, sugar, honey, etc.), cakes and breads, and greasy or fatty foods (pies, butter, liver, and bacon).

Nests can be found outdoors and almost anywhere indoors (light sockets, potted plants, wall voids, attics, in any cracks and crevices) particularly close to sources of warmth and water.

Pharaoh Ant Control Measures
Pharaoh ants are usually much harder to control than other ants because of their ability to disperse. There may be dozens or hundreds of colonies in a single building and when a few colonies are missed during control, populations will quickly rebound. About 90 percent of the colony remains hidden in the nest, so even if 10 percent of the colony is killed by a residual pesticide, the remaining reservoir of ants is enormous.

Conventional contact pesticide applications, especially repellent products such as pyrethrins, may spread infestations to new areas with multiple colonies blossoming within the structure. These ants will avoid certain pesticides. Control is difficult and often long term (months to years), depending on the building size, wall voids, etc., especially in hospitals and food plants. Complete cooperation from the property manager and residents is essential for a successful control program.

Inspection
Carefully examine the building inside and outside from the roof to the basement, finding the ant distribution, population size, and food sources. Locate ant trails, following them to where feeding occurs. A single stream of ants moving in one direction may indicate colony movement, not foraging. Mark the established feeding trail with a sticker and date. Trails with many ants coming and going indicate a large colony. Pre-baiting (dilute honey or peanut butter on three-by-five cards) helps to identify "*hot spots*," but with experience, one will already know where such places are located. In the winter, these ants tend to concentrate near and around heat, whereas in the spring and summer, they move to the outside walls and distribute themselves throughout the building. Carefully check areas with moisture, such as pipes, faucets, air conditioners, refrigerators, drains, leaking roofs, etc.

Prevention
When insecticides are prohibited around high-tech equipment and in health areas, use sticky tapes, double-faced adhesive tapes, and masking tape (glue side out) wrapped around objects as barriers. Use a ring of petroleum jelly, non-hardening glues, sticky dust mats, or glue boards under equipment legs. Seal cracks and voids with caulking compound after applying low residual repellent insecticides such as chlorpyrifos (*Dursban*) or *Diazinon*.

Insecticides
In areas of active colonies, treat walls and ceiling voids through cracks and crevices with non-repellent boric acid dust and make bait placements. Keep the ants in the area long enough to get the slow-acting toxicants to the main colony where the workers, larvae and queens are poisoned. (A delayed-action stomach poison is recommended.) Repellent insecticides, such as pyrethrins, will move the colonies, spreading them further throughout the building.

Research has shown that it is best to use bait placement only where active ant trails are found. This ensures feeding, since some ants have not been able to find the bait even when only one inch away from the bait stations. Intersect the ant trail with bait on a cotton swab taken from the station to ensure instant feeding. Bait preference may change during the season due to changing needs of the developing colonies. An effective bait is a 99 percent boric acid formulation mixed at a 5 percent concentration by weight in mint apple jelly (about two level tablespoons of powdered boric acid per 10 ounces of mint apple jelly). Another bait is 2 percent boric acid and 98 percent light corn syrup.

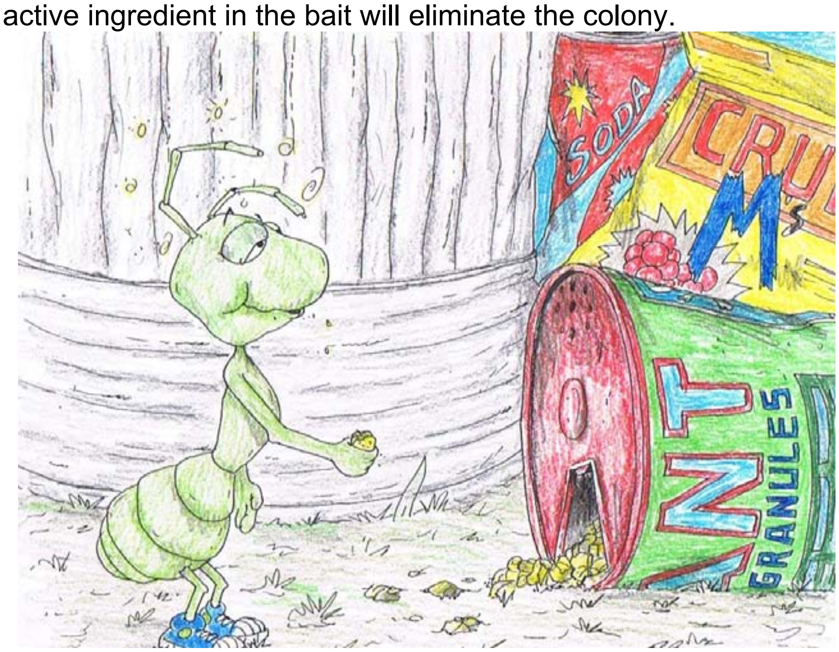
Methoprene
A commercial bait called methoprene (Pharorid) is marketed for use by pest control operators in a bait that consists of liver, honey, and sponge cake. It is often difficult to use the bait ants prefer; as ants feed on one compound, another compound placed less than 1/4-inch away will be ignored until the ants spill over into the second bait.

Boric Acid
Boric acid and methoprene baits work slowly, sometimes taking 15 to 40 weeks or more before ant eradication. A bait containing hydramethylon (same as in Maxforce roach bait stations) gives quicker results, 2 to 35 days, according to certain pest control operators.

Bait stations may include jumbo size plastic drinking straw sections, medicine (pill) dispensing cups, plastic vial caps and/or drafting (masking) tape. Placement can be made on the rear lip of kitchen counters, at plumbing pipe-wall junctions, on window sills, behind wall electrical outlets, above door frames, etc., in less accessible areas of pets or young children. There may be increased or new ant feeding activity during the early part of the baiting program. No other pesticides, heavy-duty cleaners, or paints should be used during the baiting periods to discourage ant feeding.

Bendiocarb
Applications of bendiocarb (Ficam), which is odorless, can give fast eradication of Pharaoh ants if treatments are thorough. Ficam 76 percent WP and 91 percent dust is labeled for licensed commercial and pest control operators. The bait products most recommended for Pharaoh ant control include: (boric acid plus mint apple jelly (Drax), hydramethylnon (Maxforce), methoprene (Pharorid), bendiocarb (Ficam), propoxur (Baygon) and sulfluramid (Pro-Control)).

After bait stations are placed, one will see ants trailing to and from these bait stations. Do not spray or disturb the ants or bait stations. Ants must be allowed to carry the bait back into their nest where the active ingredient in the bait will eliminate the colony.

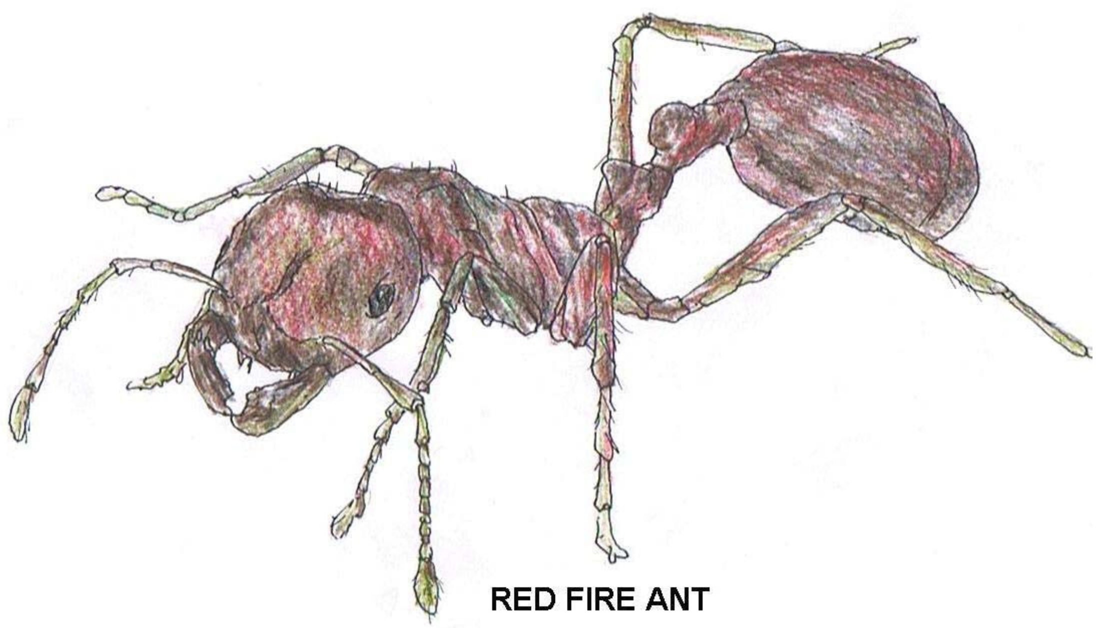


Usually, Pharaoh ant control is best achieved by a licensed pest control operator or applicator who is trained, experienced, and has the proper equipment--an Applicator like yourself. Before using an insecticide, always read the label, follow directions and safety precautions.

Red Imported Fire Ants RIFA *Solenopsis invicta*

Red imported fire ants (RIFA) are medium sized ants that build mounds of soft soil rarely larger than 18" in diameter. The ants emerge out aggressively when they are disturbed and sting. Their sting usually leaves a white pustule the next day. Harvester ants are much larger and make large bare areas with a single entrance hole to the colony. Leaf cutter ants are also much larger and do not have a distinctive built-up mound, but do have many entrance holes over a very large area. Other small to medium-sized ants that build small mounds will actually run away from disturbances and aren't fire ants.

Some confusion comes from the fact that red imported fire ants come in a variety of sizes (1/16 to almost 1/4 inch long) with the largest workers 2 or 3 times larger than the smallest. Native fire ants are less common in imported fire ant infested areas. Solenopsis geminata is the most common native fire ant species encountered. To the unaided eye, they are almost identical to red imported fire ants. However, geminata will have a few larger workers with large, square-shaped heads. These ants specialize in collecting and milling seeds.



RED FIRE ANT

Queens

Single queen (monogyne form): only one queen per colony or mound; slightly larger workers; members of colonies are territorial; mound densities usually 2080 mounds per acre; fewer ants per acre.

Multiple queen (polygyne form): dozens of queens per colony; smaller average worker ants; colonies are interconnected; mound densities 100 to 1,000+ per acre; more ants per acre.

Difference between Fire Ants and Termites

Although most ants are recognizable, some forms of winged ants are often confused with termites, especially during the termite swarming season. The front pair of wings on ants is larger than the hind pair, while the four wings of termites are approximately the same size.

Ants have "*elbowed*" antennae and a "*thin waist*," being narrow between the thorax and hind abdominal segments. Termites have the thorax and abdomen broadly connected and their antennae are straight and hair-like.

History

Where are Fire Ants From?

Fire ants are from South America. They entered the U.S. through Mobile, Alabama, probably in soil used for ships' ballast. They were accidentally introduced around the 1930s and have been spreading ever since.

We Didn't Used to Have Fire Ants When I Was a Child. Why Do We Have Them Now?

Red imported fire ants are very aggressive, efficient competitors. Since the 1950s, the ant has been spreading northward, westward, and southward from Texas. Their northward spread depends on temperature. Cold winters tend to push them back. Western spread is largely dependent on water. They will mostly be found in urban areas, creek bottoms, irrigated land, etc. The entire Pacific Coast is fertile ground for infestation. The bad news is that they are probably here to stay. The good news is that with relatively little cost and effort, you can prevent most of the problems they cause using currently available methods.

Fire ant mound; right side is Fire ant damage to an electrical transformer.

Medical Importance

Why Do Fire Ants Appear to Sting at the Same Time?

Fire ants are sensitive to vibration or movement and tend to sting when the object they are on moves. The ants swarm up a person's leg, and when one ant stings, that person jerks or moves. This triggers many of the other ants to sting in response. Thus, it appears they all sting at the same time, and most do.

Is Their Sting Lethal?

Only to a very small portion of the population who experience severe allergic reactions. Fire ants inflict a fiery sting, which causes a small blister or pustule to form at the site of each sting after several hours. The blisters become itchy while healing and are prone to infection if broken.

If You are Stung by a Fire Ant:

Apply a cold compress to relieve the swelling and pain.

Gently wash the affected area with soap and water and leave the blister intact. People who are allergic to insect stings should seek medical attention immediately. On rare occasions, fire ant stings can cause severe acute allergic reaction (anaphylaxis).

What Should I do if I Get Stung?
There really isn't much you can do, except watch the area for excessive swelling, itching, or redness, or other symptoms like shortness of breath, thickening of the tongue, sweating, etc., that could indicate a systemic allergic reaction. Treat stings as you would stings of other insects, and keep them clean and intact to avoid getting secondary infections.

What if I Have an Allergic Reaction?
Seek medical help immediately!

Are They as Lethal as Killer Bees?
They both attack en masse and both can cause fatal allergic reactions, but that's where similarities end. Africanized bees can overwhelm and kill even healthy, non-allergic people, but encounters are rather rare. Fire ants can't overwhelm a healthy, mobile person and even hundreds of stings are rarely fatal. However, fire ant mounds are extremely common. So the chance of being killed by bees is higher if you come across them, but the chance of being killed by fire ants is higher only if you are highly allergic or cannot quickly get away from them. The chances of either are very small.

Impact of Red Imported Fire Ants

They're Killing the Quail, Deer, Lizards, Songbirds, Horny toads, etc. Why Isn't Anything Being Done?
There are things being done, but it's not an easy problem to solve. First, imported fire ant control using today's methods provides only temporary suppression and costs money on a per- area basis. Wildlife occurs over large areas, which means it would make the cost of periodic treatments prohibitive. Research is being supported to document the impact of the imported fire ant on wildlife and evaluate ant management approaches. While some wildlife species are undoubtedly declining due to fire ants, they are also declining due to land use practices and weather extremes, for instance. There is great hope that the biological control agents currently under investigation will spread into wildlife areas and permanently reduce imported fire ant populations there.

Are the Ants Killing my Trees?
The ants are mainly using the trees as a nesting place. Ants in mounds occurring at the base of the trunk are probably not causing any damage to well-established trees and may actually be helpful by preying on other insects that are feeding on parts of the tree and reducing compaction by tunneling in the soil.

Why Do Fire Ants Get into Laundry?
This is a convenient place that resembles lots of tunnels for the ants. Often reports of ants in laundry occur following a flood or severe drought and are observed in utility rooms, bathrooms, or near the water heater where ants have access to the area from outside. When it floods they move in into any good dark place but in drought conditions, they tend to move to moist areas.

Fire Ant Management Approaches
Can Fire Ants be Eradicated Completely?
Red imported fire ants cannot be eradicated completely with methods available today. They can be eliminated temporarily from small areas, with proper control methods. Their biology and spread make it economically, technically, and ecologically impossible to eradicate them from larger areas.

What is the Best Product for Killing Fire Ants?
There probably is no single "*best*" method for managing RIFA. Technical Learning College does not like to endorse any specific products but will mention products, which we have tested in the field.

How Do I Eliminate Them from My Yard?
There is no single, easy answer for every situation. Most people with more than a handful of mounds will be most satisfied with just bait or the Two-Step Method. Remember, no method is 100% effective all the time, though some come close, and no method is permanent. The ants will reinvade, with new colonies probably appearing after the next rain and certainly within a year.

What is the "*Two-Step Method*" for Controlling Imported Fire Ants?
One proven method of reducing imported fire ant populations in heavily-infested home lawns and ornamental turf is called the "*Two-Step Method*" of fire ant control.
Briefly, it's the:
1) once or twice per year broadcast application of a bait product (e.g., Amdro®, Logic®, Award®, or Ascend® and others) and waiting several days to a week before;
2) treating nuisance mounds, using an individual mound treatment, such as a dust, granule, bait or drench insecticide.

Otherwise, wait for the bait treatment to take effect. This method reduces the over-reliance on use of individual mound treatments and is suitable for treating larger areas.

Why Tackle Fire Ants in the Fall?
An ideal time to apply bait-formulated fire ant insecticides is from late August through October to allow the baits to reduce fire ant populations over the winter.

It's been Dry and I Don't See Them. Are they Still Around? Why Should I Treat Them Now?
The ants are still there, just not making mounds because of the heat and drought. They are deep in the ground during the day and come out to forage at night. Ants are often more of an indoor problem now, as they come in after food and water. Treating now can be very effective since the ants are weakened anyway. Using individual mound treatments during hot, dry conditions is not a good idea because mounds are absent and/or ants are deep. Baits can work quite well if the ants are out foraging to pick it up. It is best to treat in the late afternoon or evening. You will need to know if thunderstorms are a possibility, be sure there is no dew on the grass, and make sure the bait will not have to sit in the hot sun all day. Most of the bait will be picked up by morning.

Which Bait do I Use? Baits Take Too Long. Baits Don't Work.
The key to using baits is patience. Applied properly and using a fresh bait product, a broadcast application will give 80% to 90% control, rarely 100%. For instance, Amdro® is the fastest acting, giving maximum control in 3 to 6 weeks. Logic® or Award®, when applied late in the year, may take several months to provide maximum control, but will suppress ant colonies for a year or more.

One approach, for heavy imported fire ant infestations is to treat with Amdro® first for fast knockdown, then come back with Logic®/Award® for longer durations of control as ants start to re-infest the area some months in the future. Other baits include Siege®, Award®, Ascend®, and Raid® Fire Ant Killer.

We Tried Using Those Baits, But They Don't Seem to Work. I'd Like to Use Something Safe. What Do you Recommend?
The baits do work when used properly. The thing to remember is the ants collect the bait as a source of food. Baits will go rancid in a relatively short time, as does other food that contains oil.

Additionally, putting the bait out at the right time of day and at the correct rate (1 to 1 1/2 lb/acre) is critical. If the ants are not actively foraging, they will not pick up the bait. The best times to make bait applications generally are midmorning after the dew has evaporated, or late afternoon on hot days when the air begins to cool. Always read and follow closely the directions provided on the product label before using any pesticide.

Are There any Biological Controls Out for Fire Ants? I Heard About a Fly that is Supposed to Kill Fire Ants, What's the Story on That?
The United States Department of Agriculture is conducting research on the Phorid fly as one of several potential biological control agents for helping to control fire ants. However, this research is in the beginning stages. We may be years away from any type of control these flies may provide.

Even in South America, where the imported fire ants and parasitic flies come from, the flies only affect about 3% of the ants in a colony. Some biological control agents that have already been marketed include predaceous mites, parasitic nematodes, and the fungus called Beuveria bassiana. Scientific studies are being conducted to evaluate the effectiveness of some of these natural enemies, but others remain untested or have not been shown to be highly effective when used as directed.

Why Don't We Use Mirex?
Mirex was an effective ant killer, but it was one of the most persistent compounds ever made. Mirex belongs to a group of chemicals that have mostly been banned from sale or use because their ingredients, or their degradation products, accumulated in biological systems.

Over-the-Counter Baits
Over-the-counter baits at consumer retailers are limited to *Amdro* and *Combat* (hydramenthylnon); *Raid Ant Bait* (abamectin) - which is now an old product; *Spectracide Ant Bait* (pyripoxyfen) which is formulated at 1/10th "*conventional*" formulation concentration and costs 10 times as much to apply as conventionally formulated products.

Step One: Baits
Fire ant baits consist of pesticides on processed corn grits coated with soybean oil. Worker ants take the bait back to the colony, where it is shared with the queen, which then either dies or becomes infertile. Baits currently available include Amdro, Siege, Logic, Award, Ascend, or Raid Fire Ant Killer. Baits are slow-acting and require weeks or months to achieve 80% to 90% control.

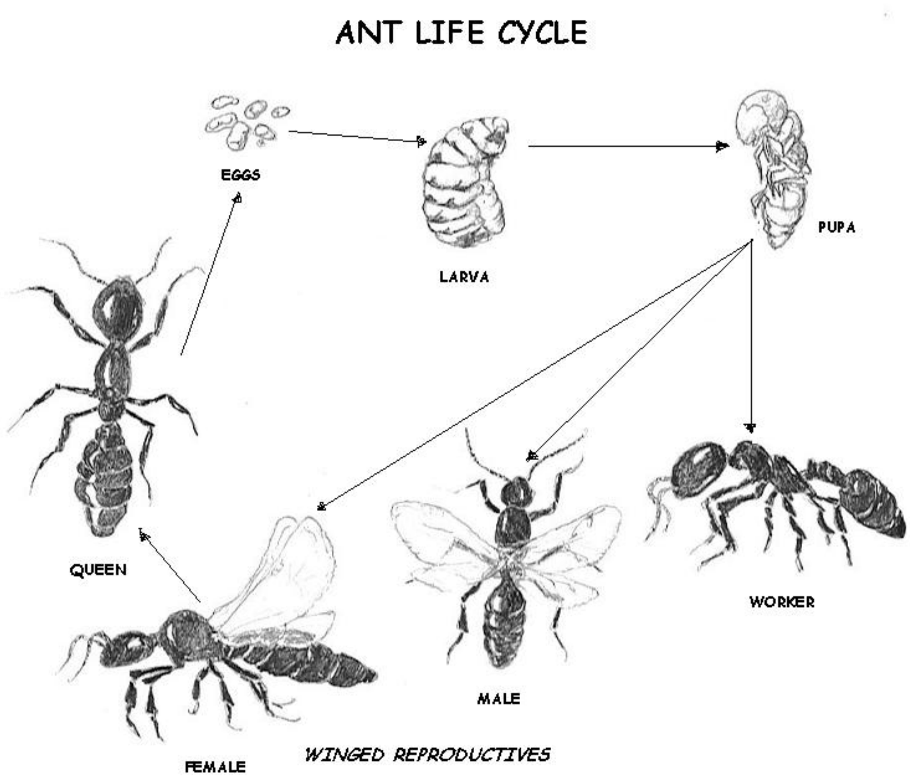
Bait Products
Bait products can be used to easily treat large areas effectively. They contain extremely low amounts of toxins.

For best results:

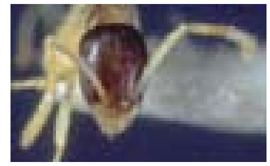
- Use fresh bait, preferably from an unopened container.
- Apply when the ground and grass are dry and no rain is expected for the next 24 to 48 hours.
- Apply when worker ants are actively looking for food, usually in late afternoon or in the evening. To test, put a small pile of bait next to a mound and see if the ants have found it within 30 minutes.
- Apply baits with hand-held seed spreaders. Don't apply baits mixed with fertilizer or seed.
- Baits can be applied anytime during the warm season. When applied in late summer/early fall, ants are still foraging, and it's easier to predict weather patterns. Then the bait can take effect over the winter while you're indoors. Re-apply baits once or twice a year.

Step Two
Individual Mound Treatments
Chemical: With dust products, no water is needed and they act fast. However, they leave a surface residue. Liquid drenches generally eliminate mounds within a few hours and leave little surface residue after application. Granular products are relatively fast acting and usually require putting granules on and around the mound and then sprinkling 1 to 2 gallons of water on them without disturbing the mound. Closely follow directions on the label.

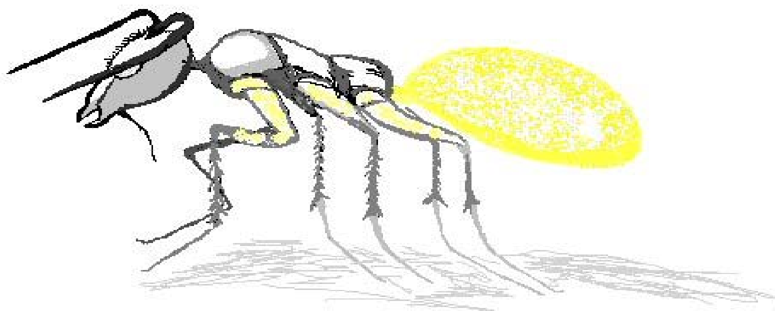
Organic: Pouring 2 to 3 gallons of very hot or boiling water on the mound will kill ants about 60% of the time. Otherwise, the ants will probably just move to another location. Very hot or boiling water will kill the grass or surrounding vegetation that it is poured upon. Other natural or organic methods include mound drench products containing plant derived ingredients (e.g. botanical insecticides) and biological control agents.



Ghost Ant *Tapinoma melanocephalum*
Subfamily Dolichoderinae



Ghost ants look like tiny, white apparitions who suddenly appear and seem to disappear just as quickly. Workers are 1/16 inch (1.5 mm) in length. The legs, pedicel, gaster, and antennae are pale, almost translucent, in color and the head and thorax are darker. For this reason, the ghost ant is also known in some areas as the black-headed ant.



Reproduction
Colonies of ghost ants tend to be moderate to large in size and multiple queens are present. New colonies are started by "*budding*" where one or more reproductive females, several workers, and possibly some brood (larvae and pupae) migrate to a new nesting site. Their biology is similar to the Pharaoh ant. Ghost ants tend to forage in a more random pattern than the pharaoh ant, so that feeding trails may be more difficult to recognize. These ants have a high need for water and may be commonly found in or around kitchens, baths, or other moisture sources.

Distribution
Ghost ants are found in warm climates and can be a big problem in tropical areas of the world. Ghost ants are highly adaptable in their nesting habits, nesting in a variety of places. Inside, they can be in wall voids, behind baseboards, between cabinets, etc. They also like to nest in the soil of potted plants. Ghost ants have been reported in many areas of the United States, as well as in Canada, Puerto Rico, and the Caribbean Islands. They are a well established pest in Florida and Hawaii. The introduction to northern states may have occurred via potted plants shipped from Florida to northern greenhouses. It is also believed that these pests can hitchhike in the luggage of tourists.

Foraging activity indoors is typically concentrated in the kitchen or bathroom, with a high need of water, although any room can be affected. The nesting habits are similar to Pharaoh ants. Outside, they can be found nesting in soil of potted plants, under stones, under and inside logs and firewood. They also nest in cavities and crevices in trees and shrubs. Ghost ants will enter structures, usually by trailing from nests along the foundation or by branches of trees and/or shrubs that contact the structure. They tend to forage in a random pattern; feeding trails may be difficult to spot. Workers forage from these onto and up the walls of buildings, entering through cracks around doors, windows, and soffits. The hollows in pool enclosures also seem to be a prime nesting site. In kitchens, they prefer to forage on sweet items such as packages of marshmallows, syrup, honey, candy and sugar.

Ghost ants will also forage on grease deposits although not as readily as they will on sweets. Trails are often very difficult to see due to the tiny size and pale coloration of these ants.

Foraging and feeding
Workers follow scent trails along the edges of structures for protection. They can often be spotted trailing under the edge of carpets and up the sides of the building, searching for entry points. Ghost ants prefer sweet foods, particularly honeydew secreted by aphids and mealybugs. The ants will herd and protect them from their natural predators, insuring the safety of their living food source. They are also predacious, attacking living insects, eggs and larvae of flies and butterflies. Indoors, ghost ants will seek sweet food such as candy, fruit and sugar.

Implication
Due to their predacious nature ghost ants are a particular problem in butterfly houses and other facilities that raise or store live insects. They will attack the valued insects and will carry off the eggs and larvae of flies and butterflies.

Recommended Products and Treatment
Baiting is the preferred treatment over typical residual spraying, to eliminate the entire colony. The use of residual sprays or dusts will cause stress on the colonies, causing them to split into sub-colonies that scatter to other areas in the structure. This is also called budding. After spraying, the problem can be worse than at the beginning. When you bait, you will want a slow-acting bait. Quick-kill insecticides and baits will only kill the foraging ants, not allowing the foraging ants to take the bait back home to feed the queen, nest workers and brood. If the current ant bait that you are using is not acceptable to the ants (if they are not visiting the bait), it is recommended that you change the baits. Ants require carbohydrates sugars, proteins, and greases. They find a variety of these sources in nature. Examples are: other insects (proteins and greases), nectar, aphid honeydew, and plant products (sugar and carbohydrates).

The Recommended Products for the Protein/Grease Eating Cycle Would Be:
- Maxforce Ant Bait Stations
- Flourguard Ant Bait Stations
- Maxforce Ant Granulars
- Advance Carpenter Ant Bait

The Recommended Products for the Sugar Eating Cycle Would Be:
- Maxforce Ant Killer Bait Gel
- Uncle Albert's Gel Bait
- Revenge Liquid Ant Bait
- Maxforce Granular Ant Bait is an excellent choice for the outside, feeding all their dietary needs.
- Ant bait stations such as: Ant Cafes small or large plastic cubes (that snap shut) that keep the gel or dry granulated bait inside, may serve to keep the baits intact.
- Dr. Moss Liquid Ant Bait can be applied to areas where ants are foraging. For use of Dr. Moss Liquid Ant Bait, you should use the Dr. Moss Liquid Ant Bait Station

Perimeter Treatment with Good Residual Sprays Such As:
- Suspend or Demon WP can at times prevent these ants from entering the structures.

Key

The key to using baits is patience. Applied properly and using a fresh bait product, a broadcast application will give 80% to 90% control, rarely 100%. For instance, Amdro® is the fastest acting, giving maximum control in 3 to 6 weeks. Logic® or Award®, when applied late in the year, may take several months to provide maximum control, but will suppress ant colonies for a year or more. One approach, for example, for heavy imported fire ant infestations is to treat with Amdro® first for fast knockdown, then come back with Logic®/Award® for longer duration of control as ants start to re-infest the area some months in the future. Other baits include Siege®, Award®, Ascend®, and Raid® Fire Ant Killer.

Regular Inspections

Regular inspections and service are necessary to find and treat new colonies as they move in from neighboring properties. These perimeter treatments can keep your home or business pest free. We suggest a regular treatment on the exterior with Demand, Tempo, or Suspend.

Locate and Treat Colonies

Drench colonies living in the soil or under items on the exterior with Demand, Suspend, or Tempo. With mulch, be sure to rake it back to get good penetration where colonies may be thriving. Follow up with a broadcast application of granule such as Talstar G.

If you know with some certainty where the colony is living inside, then you can treat them directly by drilling a small hole into the wall void at the base (directly above the baseboard) and injecting a dust, such as Delta Dust, Drione, or Borid Turbo.

General tips for limiting ant infestations include:

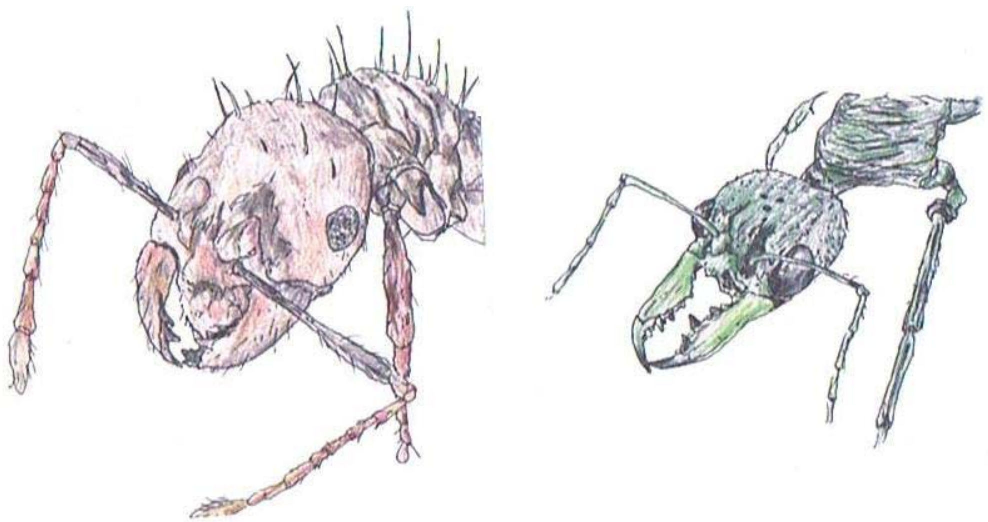
- Eliminate piles of lumber, bricks, or other debris that could serve as nesting sites for ants.
- Keep landscape mulch less than 2 inches thick and at least 12 inches away from foundations.
- Ensure the sprinkler system does not spray directly onto the foundation.
- Seal as many cracks in the building's exterior as possible.
- Keep tree and shrub branches cut away from touching the building.
- Consider re-landscaping to avoid using plants that are prone to aphids and similar insects. At the very least, treat such plants for aphids regularly.

A thorough inspection both inside and outdoors is crucial to determine ant nest location(s). Inside look primarily near moisture sources (sinks, potted plants, etc.) and secondarily near food sources (sweets stored in cabinets, etc.). Check carpet edges and shoe moldings. Inspect electrical outlets and telephone jacks, especially in the kitchen and bathroom. Check walls around possible entryways (window and door frames, utility lines, weep holes, etc.) for trails of ants as well as along edges and corners. Follow any trails of ants back to their nest. If the ants are associated with an outside/ perimeter wall, then go outside and look for ants trailing along the wall on the opposite side.

If the nest(s) cannot be located, it may be necessary to prebait with sweets such as jelly in short pieces of soda straw to draw the ants out. Place such prebaits where ants have been seen, in electrical outlet boxes, along carpet edges, in food cabinets, etc. Check these prebait placements in 24-48 hours for activity. If ants cannot then be found coming in from outdoors, use one of the commercial baits for control. Try both protein-based and sweet baits.

Outside, inspect along the foundation wall, patio, and sidewalks by pulling back the grass and/or mulch. Then pull back any mulch at the base of trees and shrubs with a rake. Check debris in tree/shrub crotches using a screwdriver because fire ants also nest here.

Turn over any stones, bricks, logs, firewood, and debris on the ground especially near the foundation; as much as possible such items should be eliminated. Check any branches of trees/shrubs in contact with the structure; these should be trimmed back to eliminate contact. Follow trailing ants back to their nest. Treat nests with an appropriately labeled pesticide. If there is continual ghost ant invasion from the outside, a perimeter treatment using a microencapsulated or wettable powder formulation of pyrethroid should be applied.



FIRE ANT **BULL ANT**

CLOSE-UP COMPARISON OF THE FIRE AND BULL ANT

IPM Control Program
An Integrated Pest Management (IPM) approach offers a greater chance for control of ants. An IPM approach incorporates all available control methods into a pest management program. IPM methods include identification, inspection, sanitation, exclusion, and chemical strategies.

Collection Tip
One way to collect ants for identification is to place a dab of honey or sugar water in the center of an index card. Place the index card covered in ants into a plastic bag, then place the bag in the freezer. The cold temperatures will slow the ants down or kill them.

When they are immobilized, the ants can be easily tapped into a vial of alcohol and submitted for identification.

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.

Leaf Cutter Ants *Atta texana*

Leaf cutter ants are mounded ants; like fire ants, they establish a mound outside. Found mainly in the United States in south central and eastern Texas and into parts of western Louisiana, they are also called "*cut ants*" or "*parasol ants*."

Leaf cutter ants are mainly a rural, agriculture pest, but can be found in subdivisions. Leaf cutter ants usually come to your attention when plants, trees or shrubs are being stripped of their leaves. The usually select one type of plant to feed off, ignoring others.

Leaf-cutter ants are major agricultural pests in Central and South America. It has been estimated they do $1 billion damage per year in crop losses in North and South America.

Although primarily an agricultural pest, this insect on occasion may invade the home for cereals. In the United States, the Texas leaf-cutting ant occurs in Texas and Louisiana. This ant is believed to cause a total yearly loss of $5 million in the United States.

Appearance
The worker ants range in size from 1/16"-to 1/2 ". They are red, with two nodes. The winged reproductives or swarmers produced by the leaf cutter ant colonies are quite big. The females are well over 2 inches long. The males are much smaller. They are rusty brown. A relatively large ant with a spiny body and long legs.

Inspection
Sometimes, they enter structures, but don't stay long. Look for nest sites that have high moisture, such as creek beds, drainage ditches, and streams. Sometimes you can discover their nest by following the foraging ants' home. A nest will have many entrances with craters of loose soil that have been deposited above. During the summer, workers forage during the night. They will forage in the daytime during the spring and fall, unless it is rainy or overcast. A "*trail*" of leaves can lead you to a nest, as well. Try to discover the entrances to the nest for possible treatment.

The swarmers often swarm in the night during the months of April or May. They are attracted to lights on buildings and can be found crawling, in large quantities, on buildings, following a major swarm. They cause no real damage.

Diet
Using their scissor-like jaws, they completely strip trees and other plants of their foliage, carrying back the leaves to their vast underground nests, where millions of ants live. It is in these chambers that leaf-cutters do something very unusual with the leaves that they bring back to the nest.

The leaves are not eaten; they are chewed into a pulp-like material, which soon sprouts a fungus. This special, mushroom-like fungus serves as the colony's only food. Being very selective about the species of leaves they collect causes these ants to travel several hundred yards on leaf-gathering foraging. The ants leave an invisible scent on the trails they use in order to find their way home.

Nests
The nest may cover 3,000 to 4,500 square feet and may be 8 feet or more deep. A nest has many chambers containing fungus, perhaps two to three dozen, and many dozens of entrances. In addition, the nests of some species of leaf cutter ants may contain 1,000,000 or more workers. Their queens are among the largest of ants.

Beneficial Insects
Leaf-cutter ants help maintain the health of the environment. The by-products from the leaves, fungi, and ant wastes fertilize the soil.

Recommended Products and Treatments
It is recommended that you drench the mounds with a weakened diluted residual insecticide; such as *Conquer*. However, the nest may be deep, and often located near bodies of water, so if in doubt, call your local extension agency for their recommendations.

Argentine Ants

History
Since the early 1900s, Argentine ants have spread to almost every corner of the globe by hitchhiking on cargo ships. The invaders live in unusually cooperative super colonies that span states, as in California, and whole regions, like the entire Mediterranean coast, according to Argentine ant specialist Neil Tsutsui of the University of California at Davis.

However, new research is revealing that the impressive expansion of what has become the most common household pest in the world has also led to intense inbreeding that's now causing the ants to become unnaturally hostile toward their own kind.

"It's sort of an unusual state of affairs," said Tsutsui of the Californian super colony. *"Because most invading Argentine ants sprang from a few ants that came on ships, they tend to have a limited variety of genes in their colonies, like any inbred animals would. That's very different from Argentine ants in their native Argentina, however",* said Tsutsui.

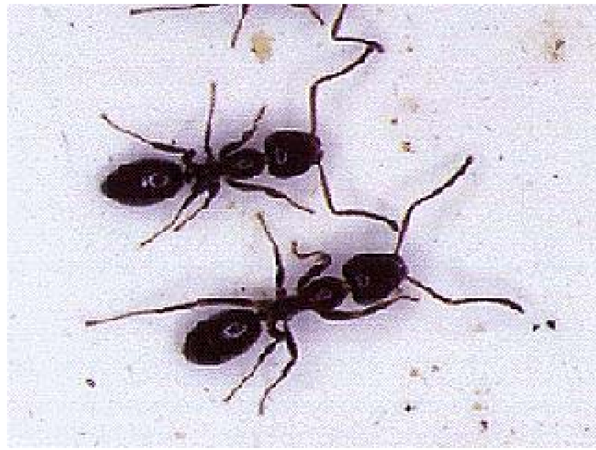
"In their native habitat, Argentine ant colonies can hold a wide array of ants with diverse genes. That makes the ants remarkably tolerant of Argentine ants that are genetically different, something they can detect through odor", explained biologist David Queller of Rice University.

"Because the globe-trotting ants have formed very large colonies in foreign lands with very little genetic diversity, they now react unusually aggressively to ants that smell like they are not part of their big, inbred family", said Tsutsui. *"Very large colonies have a very narrow spectrum of odors,"* Tsutsui explains. So when a diversity-tolerant Argentine native hops off a ship into a super colony's territory, it runs into very hostile ants. In fact the super colony ants attack preemptively," he said.

"The irony of the situation is that the super colonies actually could benefit from the influx of new genes", said Tsutsui. *"In large gene pools there are often useful genes hidden in the population that help species survive disease outbreaks or changes in their environment. By attacking the more genetically diverse ants, the super colonies could be hurting their long-term survival".*

"On a more theoretical level, it's just fascinating to watch a species switch from being unusually cooperative to being aggressive", said Queller, *"because those are two fundamental survival strategies seen throughout the history of life".*

Characteristics
Size: About 1/8”-inch long.
Color: Brown. It is most often confused with the odorous house ant, but the node of the Argentine ant has a sharp, pointed peak, while that of the odorous house ant is flat in shape and is hidden by the gaster. A major pest for folks in Southern and Northern California.



The Argentine ant is a one node, small, shiny, brown ant with only one size of worker. Workers are usually about 1/12 to 1/8 inch long. The queen ants are much larger, sometimes reaching 1/4 inch in length. This ant is found throughout the Southeastern United States and California. They nest outdoors under logs, concrete slabs, debris, and mulch. Argentine ants build very large colonies and can move rapidly. During winter months, this ant will move indoors.

Habitat and Behavior
This species is common in the Southeastern US, and is a major problem in Southern California. A 1990 survey of urban pest ants in California showed this ant to comprise 25% of all samples collected. This ant nests outdoors under items on the ground, within landscape mulch, beneath loose bark on trees, under ground cover, in potted plants, and within piles of items, such as lumber, firewood, or under slabs of homes. Like the odorous house ant, the argentine ant may nest indoors, in walls, beneath carpeting, and other suitable voids or spaces.

Super Huge Colonies
Argentine Ants may develop super huge colonies containing thousands of workers and possibly thousands of queens. This species may be one of the most difficult to control. One reason these ants are so successful is the fact that worker ants of individual colonies are friendly towards one another, and colonies will join together to form supercolonies. When argentine ant colonies are killed or removed from the area, they can be quickly repopulated by ants from colonies on neighboring properties. An Argentine ant colony can suffer the loss of 99% of the colony's individuals, and the colony can still survive and rebuild. No significant natural enemy of this species currently exists in the United States.

Control
This Ant is Successful and Very Hard to Control Because:

- Different Argentine ant colonies in a same general locale are not enemies. Even the many queens in a single colony or separate colonies are friendly to each other.
- Argentine ants are not too "picky" when choosing a suitable site to infest or colonize. They readily move their nests during the changing seasons and other conditions.
- These pests are omnivorous; they seem to never be in short supply of food.
- Each colony of Argentine ants contains a multitude of workers.
- Each worker is more courageous and harder worker than most ants. Creatures that attempt to prey on Argentine ants are confronted with an army of stubborn bugs that never run from a fight!

- The queens of most ant species are usually egg-laying machines. The queen ant of Argentines actually helps in the care, grooming, and feeding of her young.
- Most species of ants mate and reproduce by swarming; the Argentine mates in the colony, unexposed to the perils of birds, frogs, lizards, predator insects, and extreme weather conditions. A swarmer reproductive (as seen with fire ants and carpenter ants) has about 1 chance in 1,000 of surviving and successfully reproducing. The Argentine ant queen always succeeds!
- This ant pest has no natural enemies (of any importance) in the United States.

Control of Argentine Ants
Argentine ants are difficult to control for the following reasons:

- All ants are holometabolous (complete metamorphosis), having an egg, larval, pupal, and adult stage. Foraging adult ants are only a fraction of the total colony. Broadcast spraying around the perimeter of the house targets only the foraging adult ants in the colony. Control will be temporary since the colony will simply send out more foraging ants when others are killed.
- The colony supports multiple queens if ant populations are large. If a broadcast spray around the house is the primary method of control, the Argentine ant workers and queens will scatter. When the ants scatter in sufficient numbers, new colonies can be formed. The one main colony can split into several smaller ones, all of which have the potential to grow. Thus, broadcast spraying alone can make the problem worse.
- Unlike many other ant species, Argentine ants from different colonies do not fight. Therefore, their spread is less limited because they are not territorial.
- Even with their large colony size, they are quite mobile and can move from one area to another quickly. A broadcast spray may temporarily alleviate an Argentine ant infestation. But there is a good possibility that the ants will simply move to another area until the chemical breaks down. After the chemical breaks down, the ants will return because they are constantly scouting and foraging for food, water, and nesting sites.
- Heavy mulch against the walls of houses creates pockets of moisture that these ants need.
- Potted plants are a favorite nesting site. Moving infested pots into the house can create an indoor infestation.

These characteristics combine to create a pest control nightmare. Argentine ant control is an ongoing effort. Due to the large size of colonies and their rapid mobility, even if one colony is eliminated, another will move into the area over time.

IPM Control Program
An Integrated Pest Management (**IPM**) approach offers a greater chance for control of the Argentine ant. An IPM approach incorporates all available control methods into a pest management program. IPM methods include identification, inspection, sanitation, exclusion, and chemical strategies.

Collection Tip
One way to collect ants for identification is to place a dab of honey or sugar water in the center of an index card. Place the index card covered in ants into a plastic bag, then place the bag in the freezer. The cold temperatures will slow the ants down or kill them.

When they are immobilized, the ants can be easily tapped into a vial of alcohol and submitted for identification.

Figure 1

Inspection

Find the source of the ants. Place bait or granules where the ants are foraging or nesting. Generally, Argentine ant trails will be conspicuous (Figure 1). If trails are not obvious, placing an index card with a dab of honey or sugar water where ants have been seen may help locate established trails as ants recruit to the sugar source. In general, treatments are not effective if they are not placed where ants are found.

Sanitation

- Eliminate sources of moisture (such as leaky faucets, plumbing, and free-standing water) and food because these ants are scavengers.
- Clean windows of dead insects. These ants will feed on dead insects.
- Remove the food source if ants are trailing to food. With a mild detergent, wipe ant trails after food is removed to erase the trail pheromone. The trail pheromone is a special chemical that foraging ants lay down to guide other foraging ants to food or to a new nesting place.
- Spray the ants with soapy water from a spray bottle. This will often temporarily halt ant problems if insecticide use is of concern around food or other sensitive areas. Soap breaks the surface tension of the water, causing the ants to drown.
- Check potted plants for ants before bringing the plants indoors. One way to check for ants is to water the soil thoroughly to force ants out of the soil.

Physical Exclusion

- Caulk cracks and crevices in the house.
- Keep branches from coming in contact with your house (ants will walk on them into the house).

Chemical

- Apply chemicals judiciously. Precision spot treatments at points of entry into the house, such as around window sills and door thresholds, may be effective. Broadcast spraying for these ants is unwise. A liquid insecticide will make the area repellent to ants. Ants will not feed on a bait that is placed in the vicinity of a repellent liquid insecticide.

- Bait stations designed for outdoor and indoor use have been reported to be effective in killing these ants. Look for products with delayed toxicants, such as hydramethylnon and sulfluramid. The toxicant must be slow-acting, because if ants die in the immediate area of the bait, other ants will avoid the area and not feed on the bait.

- 1 percent boric acid in a 10 percent sugar solution is a homemade remedy for many sweet-loving ants, such as the Argentine ant. There are several disadvantages to this bait. First, it is very slow-acting. Second, because the colonies are so large, they must be given a constant supply, which means the homeowner would have to repeatedly check on the bait. Even then, control is not guaranteed. The only advantage is that this bait is inexpensive.

Odorous House Ant *Piss Ant*

This native species, found throughout the United States, produces a foul odor when crushed. It smells like a "*rotten coconut*". I like to call these nasty little critters "*Piss Ants*".

Appearance
The workers are about 1/16 to 1/8" (2.4 to 3.25mm) long, and their bodies are brown to black. The antennae have 12 segments.

Reproduction
Females in the nest lay one egg daily. It takes an average of 24 days for the young to reach adulthood. The nest colonies range from 100 to 10,000 ants, but can be driven away by invading Argentine ants. Argentine ants generate strong pheromone trails when foraging. They can be easily tracked. In many areas, you will see them pathing three and four abreast.

Inspection
They forage day and night, and their nests can occur in a great variety of situations. Inside, these ants usually construct their nests in wall voids, especially around hot water pipes and heaters, in crevices in sinks, cupboards, etc. Outside, they are found in exposed soil, usually shallow, often located beneath a board, brick, stone walk, etc. They are most likely to enter buildings when their honeydew supply or sweet supply of food is reduced; such as during rainy weather or with leaf fall in the autumn.

Diet
They can feed on anything from other insects, honeydew, seeds, and plant secretions, but do prefer sweets. They are extremely fond of honeydew and attend such honeydew-excreting insects as plantlice (aphids), scale insects, mealybugs, etc.

IPM Control Program
An Integrated Pest Management (IPM) approach offers a greater chance for control of ants. An IPM approach incorporates all available control methods into a pest management program. IPM methods include identification, inspection, sanitation, exclusion, and chemical strategies.

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.

Key Words

Estivation (aestivation): A resting stage (quiescence) resulting from continued high temperature or work.

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.

Microbial Pesticide: Bacteria, viruses, fungi and other microorganisms used to destroy or control pests.

Pedipalps: Second pair of appendages of the cephalothorax corresponding to the mandibles of insects.

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.

Pupal stage (pupa): The stage in complete metamorphosis between larva and adult like the cocoon in moths.

Pesticide: A chemical or other agent used to kill or otherwise control pests.

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.

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.

Soluble Powder: A finely ground, solid material which will dissolve in water or some other liquid carrier.

Tarsi: A foot. Insect feet are made of several segments and may have pads, hairs, or hooks.

Termite: Any wood-eating insect in the order Isoptera.

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).

Lasius Neoniger

Ants can be a real nuisance on golf courses when their nesting and mound-building occur in high-profile areas. Ant mounds disrupt the smoothness and uniformity of putting surfaces, dull mower blades, and can smother closely-mowed turf.

Close-up view of Lasius Neoniger

Golf superintendents often report problems eliminating these pests with conventional insecticides. Further, ant problems in turf seem to be increasing nationwide. One theory to explain this is that residues of chlordane and other highly persistent turf insecticides used in the past have finally declined.

Another theory is that replacement of diazinon (which is highly active on ants) with more target-selective soil insecticides has allowed ants to gain a foothold on golf courses. Whatever the reason, many superintendents need effective ant controls to reduce mound building.

Lately, research has been testing new approaches to managing nuisance ants using delayed-action baits and new classes of insecticides. The results have been promising, and some of these new products are already catching on with superintendents. We are also studying the beneficial aspects of turf-infesting ants, especially their importance as predators on eggs and larvae of other insect pests.

The primary nuisance ant pest of turf is Lasius neoniger, a species that is widespread in the United States. In many areas, Lasius seems to be responsible for most, if not virtually all, ant hills on putting greens.

Problems arise when the worker ants excavate underground nest chambers, pushing up small mounds of soil. Lasius is also common in roughs, fairways, lawns, and other sunny turf sites; although there, the mounds are less conspicuous than on greens and tees.

Window sills are great entry points into a home. Spray every 7-10 days.

Characteristics of the Ideal Ant Bait

1. Must be a Slow-Acting Toxicant.
2. Must be a Non-Repellent Toxicant.
3. It must be based upon an Ant's Preferred Food Source.

Baits work because they exploit the ants' behavior of sharing food and nutrients with other ants. Passing nutrients from one ant to another is called trophallaxis. If food contains a slow-acting toxicant and the ant does not detect it, the toxicant is passed throughout the colony by trophallaxis, before killing its members, including the queen. Ant baits work only if the ants eat the bait. Eliminate any alternate food sources by keeping counters clean and storing food in sealed containers.

The Keys to a Successful ant Management Program include the Following Five Steps:
(1) Correcting any conditions conducive to the infestation (unnecessary harborage, sanitation).
(2) Locating and treating existing colonies with Demand, Suspend, Tempo, Delta dust, or Drione.
(3) Servicing the property regularly to detect and eliminate any new colonies.
(4) Application of perimeter treatments with Demand, Suspend, Tempo, or Talstar G.
(5) Application of ant baits inside with Advance Carpenter Ant Bait, Maxforce granual, Maxforce gel, or Uncle Albert's Gel Bait. Reliance on just one or two of the above steps will generally result in failure to provide any significant relief from interior infestations.

Let's Go into a Little More Detail on Each of the Above:
(1) Correcting Conditions
Eliminate any moisture problems; such as leaks or excessive moisture around the foundation. Eliminate any food sources, including honeydew associated with aphids. Branches of trees and shrubs need to be kept cut away from the structure. Cracks in the structure need to be sealed. If possible, a vegetation-free border should be created around the base of the foundation to make the area less attractive to ants and to allow for easier inspection of the foundation. This zone should be free of bark or mulch, and should consist of gravel or small stones. Remove all harborage, such as leaves, trash, mulch, firewood, bricks or lumber.

(2) Locate and Treat Colonies
Drench colonies living in the soil or under items on the exterior with Demand, Suspend, or Tempo. With mulch, be sure to rake it back so you can get good penetration where colonies may be thriving. Follow up with a broadcast application of granule such as Talstar G.

If you know with some certainty where the colony is living inside, then you can treat them directly by drilling a small hole into the wall void at the base (directly above the baseboard) and injecting a dust such as Delta Dust, Drione, or Borid Turbo.

If the colony cannot be located, baits such as Advance Granular, Maxforce Granual, Maxforce Gel, or Uncle Albert's Gel Bait can be applied to areas where ants are foraging.

(3) Service the Property Regularly
Inspect and service the property regularly to detect and treat any new colonies.

(4) Regular Perimeter Treatments
Treat the outside foundation regularly to establish a barrier that will keep ants away and out of the structure. *Note-* Always inspect thorough before treatment. If you note ants entering the structure from the outside, you may want to consider baiting in this area, as a pesticide may break off or trap the colony inside.

(5) Bait Applications on the Interior
Baits should be employed when inside colonies cannot be located and/or when combined with the strategies already mentioned. Baits such as: Advance Carpenter Ant Bait, Maxforce Granual, Maxforce Gel, Uncle Albert's Gel Bait, or Dr. Moss Liquid Ant Bait can be applied to areas where ants are foraging.

Note: With Dr. Moss Liquid Ant Bait, use the Dr. Moss Liquid Ant Bait Station.

The use of indoor bait stations such as the Ant Cafes will preserve and protect baits.

Use the Crusader to apply your dusts or baits into those tight spots or hard to reach places.

Note: Use only one Crusader for each formulation. You don't want to contaminate your bait with an insecticide.

Regular Inspections
Regular inspections and service are necessary to find and treat new colonies as they move in from neighboring properties. These perimeter treatments can keep your home or business pest free. We suggest a regular treatment on the exterior with Demand, Tempo, or Suspend**.**

General tips for limiting ant infestations include:
- Eliminate piles of lumber, bricks, or other debris that could serve as a nesting site for ants.
- Keep landscape mulch less than 2 inches thick and at least 12 inches away from foundations.
- Ensure the sprinkler system does not spray directly onto the foundation.
- Seal as many cracks in the building's exterior as possible.
- Keep tree and shrub branches cut away from touching the building.

Consider re-landscaping to avoid using plants that are prone to aphids and similar insects. At the very least, treat such plants for aphids regularly.

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.

Termite Introduction

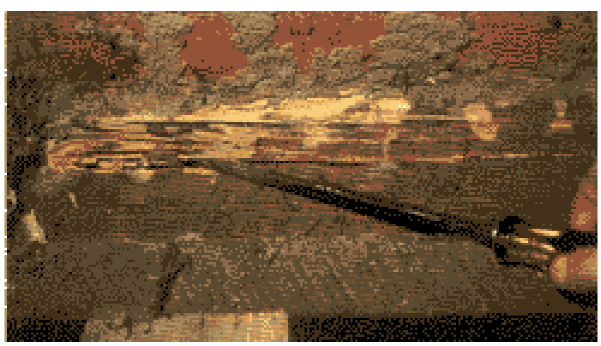
Why are Termites in an Ant Control manual?

Because it is often difficult to tell the alates apart. It takes a trained and educated eye to tell the difference between the two creatures and there tell-tales damage signs.

There are about 2,500 termite species in the world. North America has 41 termite species, most in the southeast USA. Alaska is the only state without termites. Florida's eastern subterranean termite colonies have about 250,000 members, but can have 1 million or more. A colony eats about 1 cubic foot of wood a year. Australian colonies can have two million termites. The queen can lay 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. Subterranean termites, the most destructive of all termite species, account for 95% of the damage. Two subterranean termite species, Reticulitermes flavipes (Kollar) and R. tibialis Banks, are commonly found in United States. Control of these termites costs more than $1 million each year.


Subterranean worker termite. Subterranean termite's mud tube (on glass surface).



Using a screwdriver to examine termite damage, Subs will go with the grain.

Feeding Habits

Subterranean termites feed mainly on wood and wood products containing cellulose. Termites have protozoa (microorganisms) in their intestine which provide 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.

Although termites are soft-bodied insects, their hard, saw-toothed jaws work like shears and can bite off extremely small fragments of wood. These termites do not attack live trees, except for the Formosan termite. 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, art work, books, clothing, and furniture. The most serious damage involves the loss of structural strength.

Biology
Subterranean termites are ground-dwelling social insects living in colonies. The two species 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 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. The mature colony consists of three castes: a) reproductives (king and queen), b) soldiers, and c) workers. 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. Caste: A group of insects with a specific morphology and function within a colony of social insects.

Reproduction
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 25 years.

Eggs
The fertilized female 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. 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.

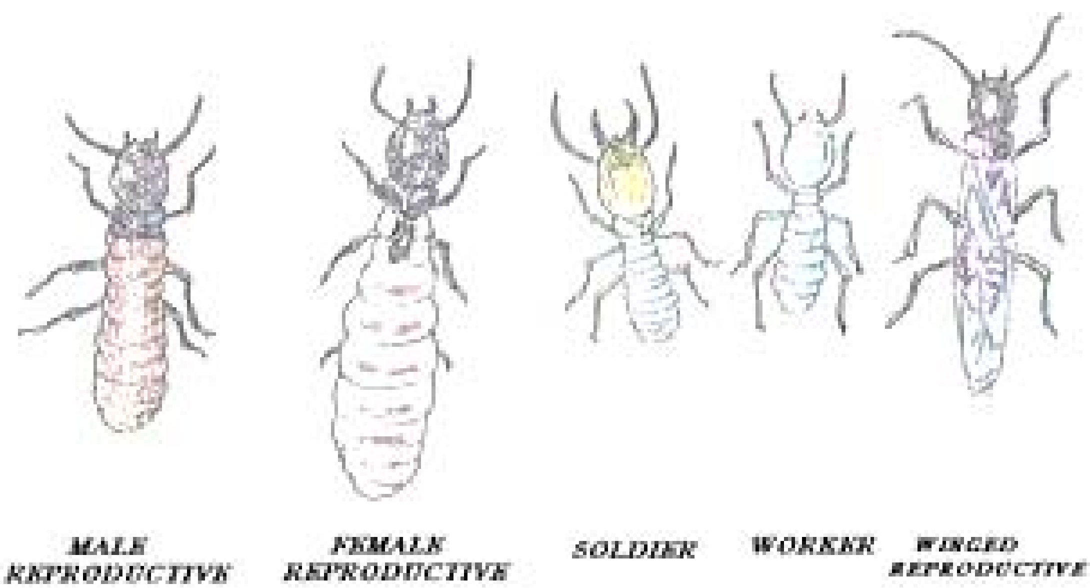
The workers undertake all the labor in the colony such as obtaining food, feeding other caste members and immatures, excavating wood for chambers, and constructing tunnels. Workers mature within a year and live from 3 to 5 years.

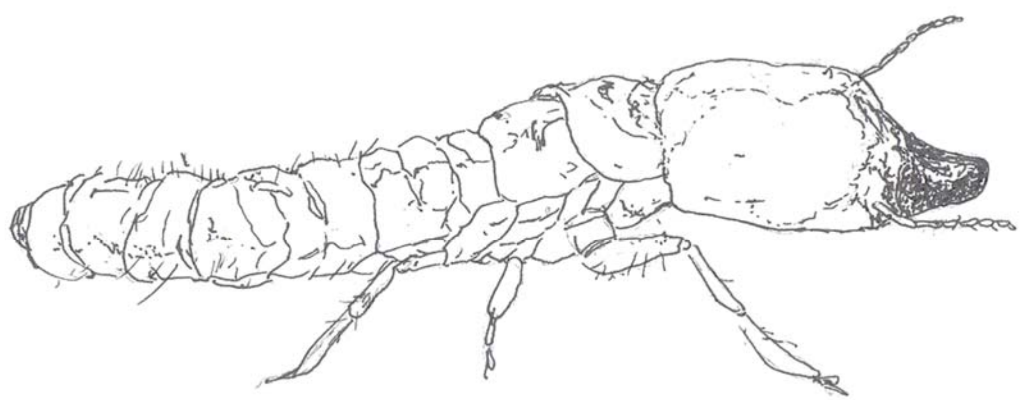
Soldiers

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 is Ants and the Soldiers can defend a small number of Ants.





DRYWOOD TERMITE (SOLDIER)

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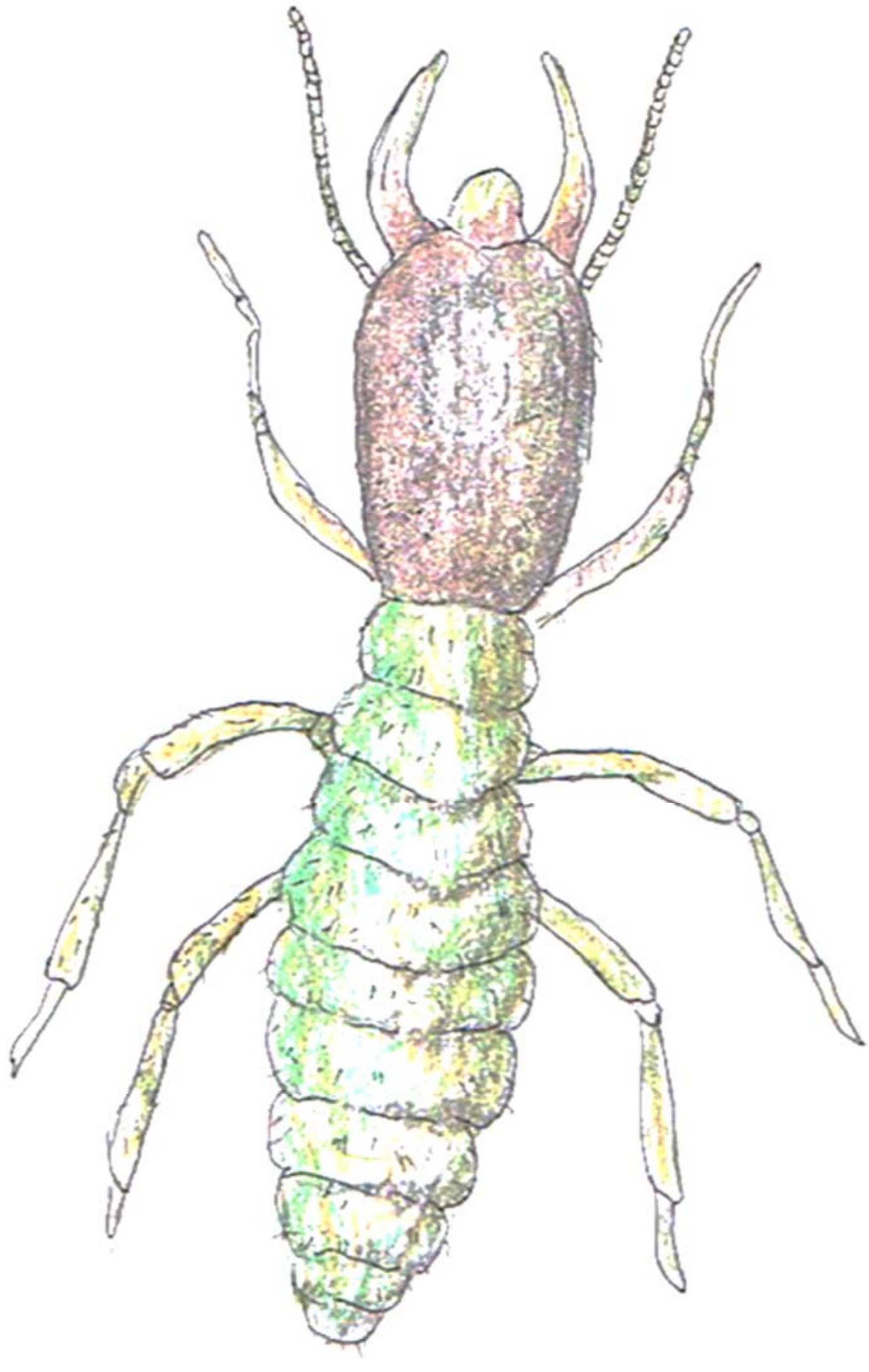


Solider

Reproduction

The female termite 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. Establishment of a 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 even older 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. 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 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 may provide 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
Termites 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 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 (10-20 cm), but sometimes are found projecting from heavily infested wood above ground.

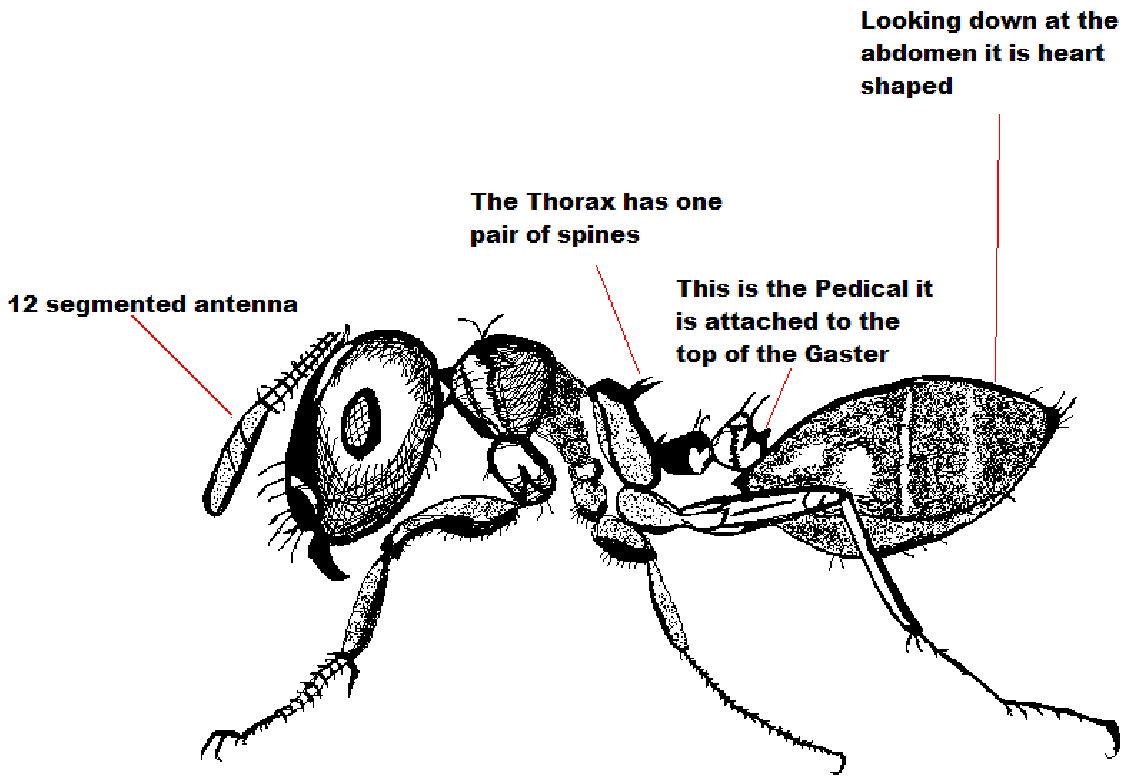
When swarmers are leaving the colony via these tubes, or directly through a hole in wood or soil, the openings are heavily guarded by soldiers and workers. The amount of damage that an infestation of subterranean termites might inflict on a structure depends on many factors. The number and size of the 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.

Severe 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 6 months is recommended.

Communication in the Colony
1. Termites primarily communicate via chemicals called 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. 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 it self.
3. Mutual exchange of foods enhances recognition of colony members.

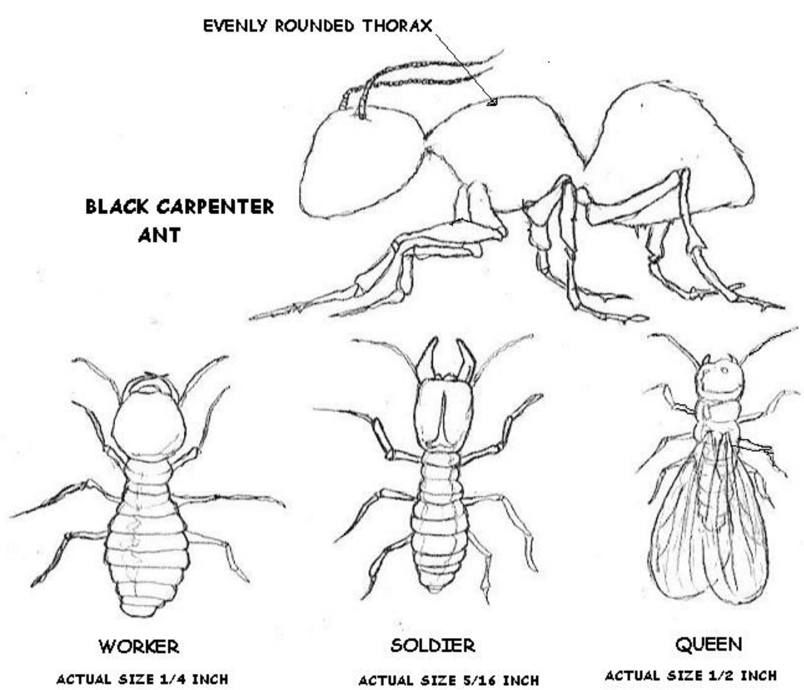

Winged dampwood termite Alate. Winged "sub" Alate.

Termite gallery structure or what humans call “serious home damage”.

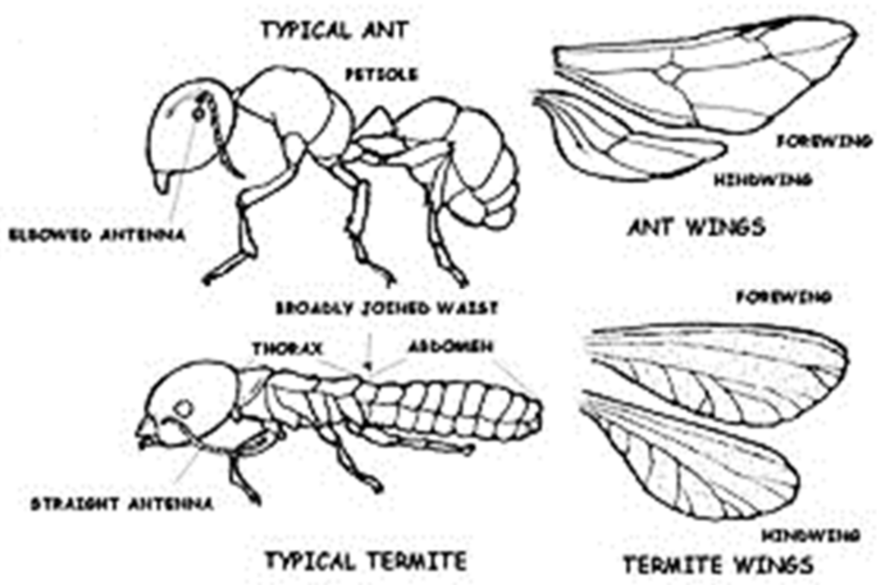


Ant Body Description

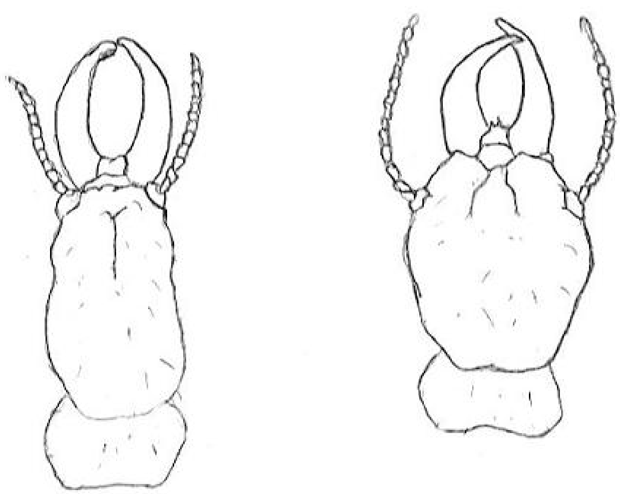
If you remove the legs off an ant, you'll have a snowman. Not so with a termite. You'll have a head and a long body.



Ant vs. Termite

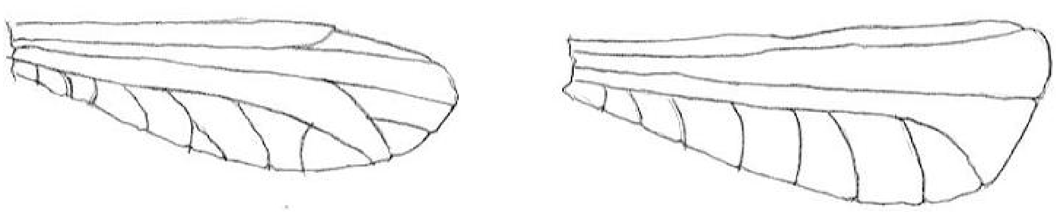


SOLDIERS

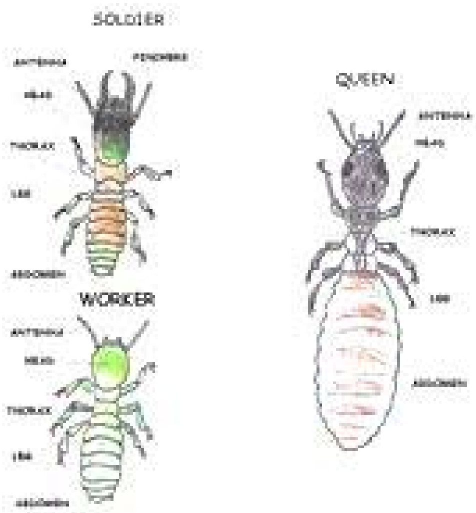


NATIVE SUBTERRANEAN FORMOSA TERMITE

ALATE WINGS

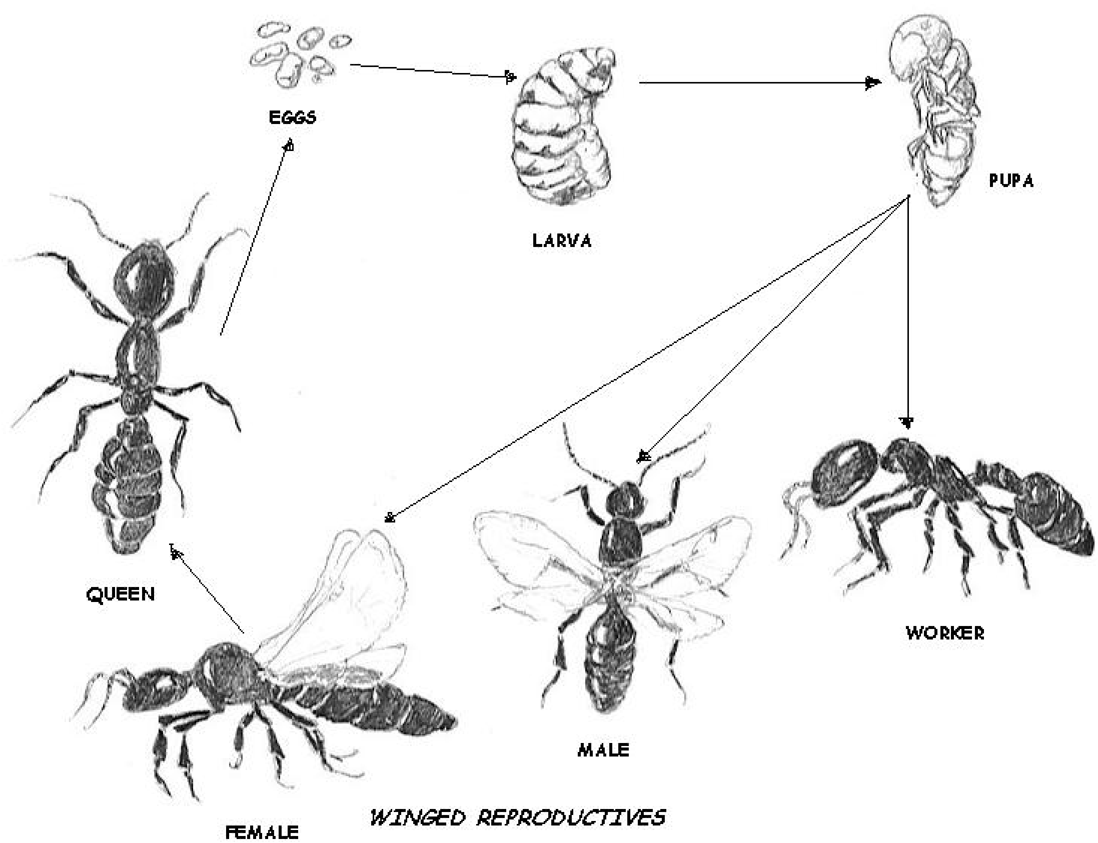


NATIVE SUBTERRANEAN TERMITE FORMOSA SUBTERRANEAN TERMITE



TERMITES

ANT LIFE CYCLE



Detection of Termites

It is important for homeowners to recognize the signs of a subterranean termite infestation. Subterranean 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 foam board.

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. 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 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.

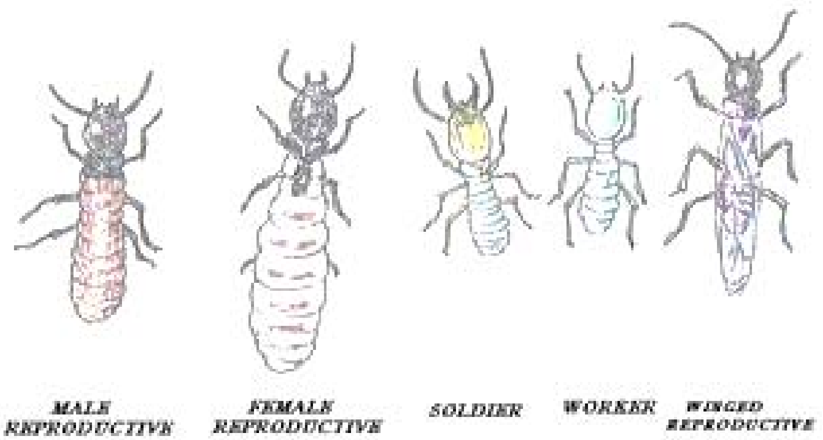
Necessary Inspection Equipment

- ➢ Flashlight
- ➢ Probe “Screwdriver”
- ➢ Ladder
- ➢ Pencil and Graph paper
- ➢ Magnifying Glass

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.

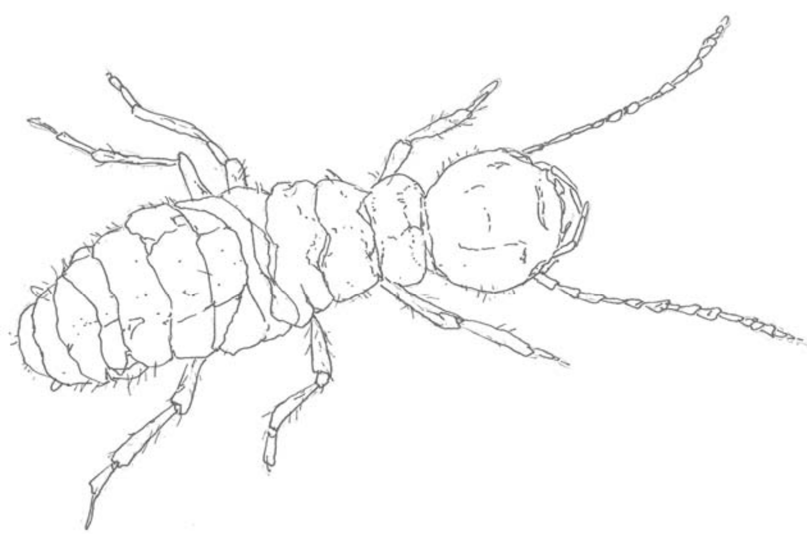
Alate emergence is stimulated when temperature and moisture conditions are favorable, usually on warm days following rainfall. Swarming typically occurs during daytime in the spring (March, April, and May), but swarms can occur indoors during other months. However, swarming occurs during a brief period (typically less than an hour), and alates quickly shed their wings. Winged termites are attracted to light, and their shed wings in window sills, 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 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. Subterranean 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.



SUBTERRANEAN FORMOSAN TERMITE

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.

Termite damage in crawlspace: A. Floor joist, B. Subfloor
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.

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.

Termite infested wood and Subs mud tubes.

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.

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.

Inspection for Subterranean Termites

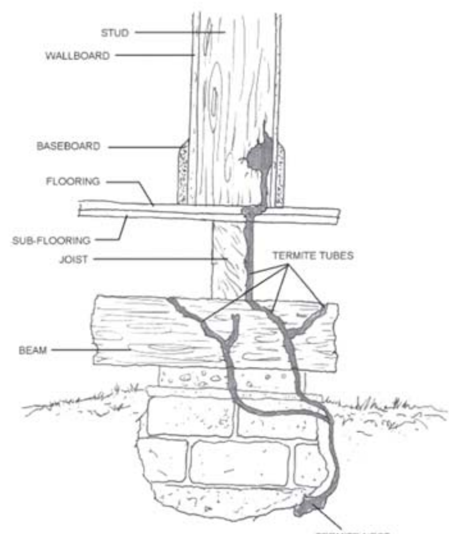
Applicators may be able to locate termite damage by probing wood with a screwdriver, ice pick, or knife. Start in the basement and use a bright flashlight. Look for mud tubes and the presence of swarmers. Termite damage/activity is often found during building remodeling or repair. Some agencies such 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.

A professional 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 are encouraged to seek two or more inspections and cost estimates. Ask for information on chemical treatment procedures, repair of woodwork, warranties, copies of the insecticide label, and other pertinent information. Compare bids before making decisions. Ask for 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). Termite 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. All of these insecticides control termites if properly applied.

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. Using a sub-slab 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

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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.

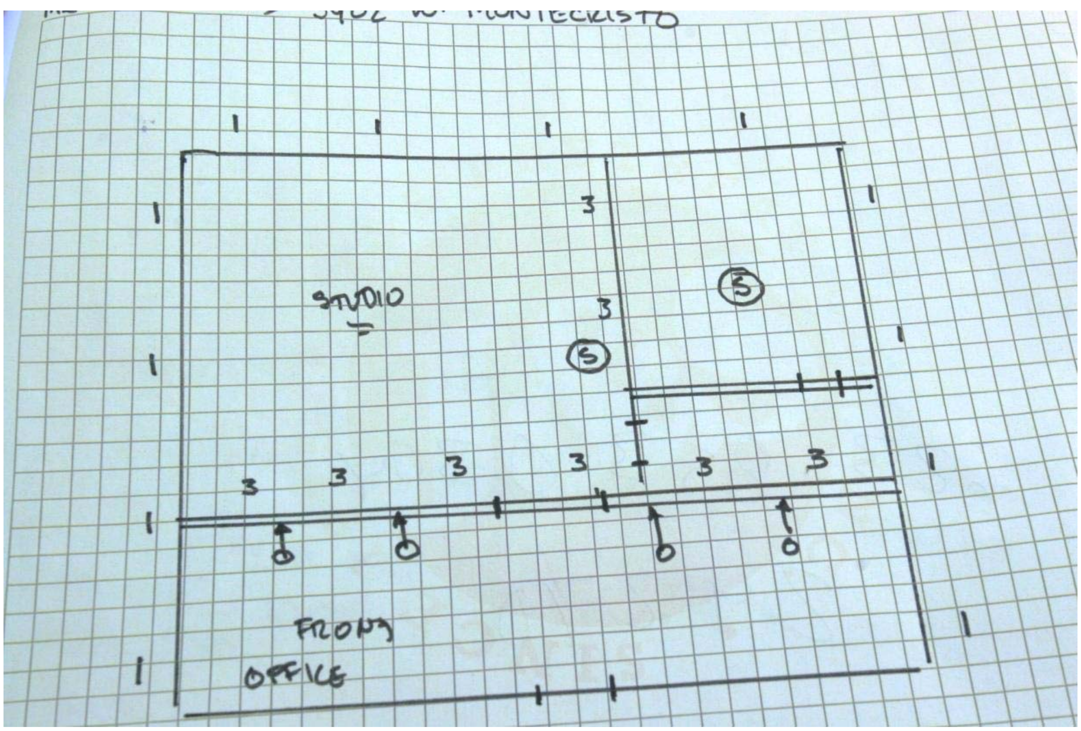
Treatment Near Ponds, Wells, Cisterns, and Faulty Foundation Walls, Around Pipes or Utility Lines
Insecticide applications through rodding is discouraged in such situations. The suggested procedure is to make a trench and remove the soil to be treated onto a heavy plastic sheeting or similar material. 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 device. So many applicators risk damaging the public water supply if they do not follow instructions and do not utilize the air gap 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 70 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.

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 they are walking dead.



Probing interior trim wood reveals termite damage

Wood Damage

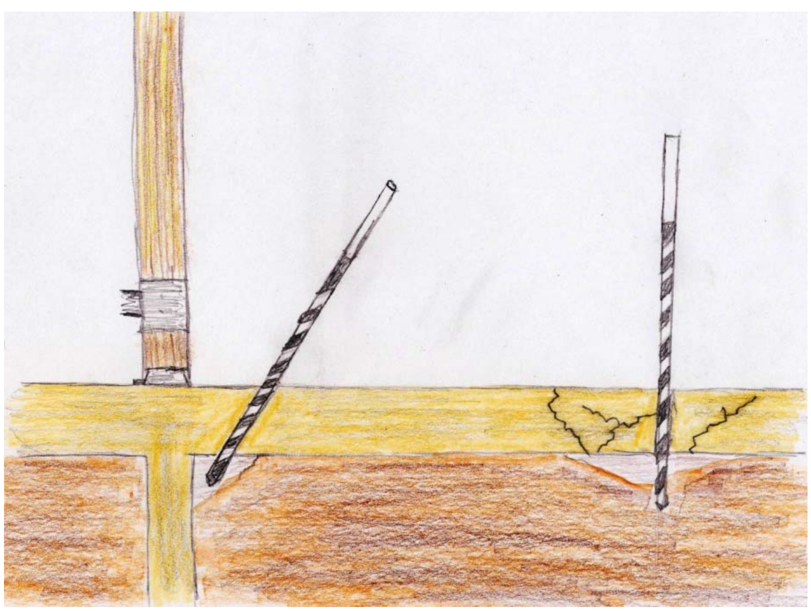
Termite damage to the wood's surface often is not evident because termites excavate galleries within materials as they feed. Wood attacked by subterranean termites generally has a honeycombed appearance because termites feed along the grain on the softer spring growth wood. Their excavations in wood often are packed with soil, and fecal spotting is evident.

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.

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.

You need to properly identify the 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.



Drilling and dusting the wall voids will help control subs. Always follow the State rule and the manufacturer's instructions. Some of my suggestions may not be allowed with certain chemicals and in certain States. There are several products that I can think of that will kill subs but few will list it on the label. When in doubt, follow the label. This treatment will also kill bed bugs and cockroaches. Below, I am trenching and drenching or some will say rodding. I am pumping 4 gallons of chemical for every ten feet of trench to kill subs.

Prevention

Preventive practices are a critical aspect of termite 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®).

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.

Ant Identification and Control Section Post Quiz

Identify the missing term or word
Ant Control
1. Ant baits can again be a useful tool in eradicating inside-the-home ant nests, although baits may not work as well with carpenter ants as with the other species mentioned. Again, workers must eat the bait, take it back to the nest, and feed it to the queen and larval ants. This type of control is _____________with treatments that prevent workers from returning to the nest with the bait.

Carpenter Ants
2. Carpenter ants are most active in the evening hours, foraging for all kinds of food, both inside the house and outside. By following the ants, you may be able to tell where the nest is. Because carpenter ants keep the tunneled galleries very clean and push the sawdust and dead insect parts out small holes in the wood, a small, fresh pile of sawdust under the nest timber is the usual sign of an active carpenter ant nest. Once a nest is found, treatment is usually easy with either an insecticide dust or spray. ____________into wall voids or the nest itself may be necessary to reinsure complete control.

Ghost Ant
Foraging and feeding
3. Workers follow scent trails along the edges of structures for protection. They can often be spotted trailing under the edge of carpets and up the sides of the building, searching for entry points. Ghost ants prefer_________, particularly honeydew secreted by aphids and mealybugs. The ants will herd and protect them from their natural predators, insuring the safety of their living food source. They are also predacious, attacking living insects, eggs and larvae of flies and butterflies. Indoors, ghost ants will seek sweet food such as candy, fruit and sugar.

Harvester Ants
4. Over the years, their numbers have been declining, and this has often been attributed to competition for food with the invasive Red Imported Fire Ant and the argentine ant. Their decline has affected many___________, especially those for which the red harvester ant is a chief source of food, such as the Texas horned lizard. Red harvester ants are often mistaken for fire ants, but are not related to any fire ant species, native or introduced. This class of ants is also known to have both male and female genesis.

Regular Inspections
5. Regular inspections and service are necessary to find and treat new colonies as they move in from neighboring properties. These _____________can keep your home or business pest free. We suggest a regular treatment on the exterior with Demand, Tempo, or Suspend**.**

Locate and Treat Colonies
6. Drench colonies living in the soil or under items on the exterior with___________. With mulch, be sure to rake it back to get good penetration where colonies may be thriving. Follow up with a broadcast application of granule such as Talstar G. If you know with some certainty where the colony is living inside, then you can treat them directly by drilling a small hole into the wall void at the base (directly above the baseboard) and injecting a dust, such as Delta Dust, Drione, or Borid Turbo.

Answers

1. Incompatible, 2. Injection of insecticide, 3. Sweet foods, 4. Native species, 5. Perimeter treatments 6. Demand, Suspend, or Tempo

Cockroach Section

Cockroach is the common name for an order of insects, the most familiar of which are characterized by their oval shape, foul odor, and their status as household pests. About 4000 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. Among these are most of the important pest species. Cockroaches are an ancient group of insects, having changed little in appearance in thousands of years. Fossil records indicate that they were the predominant insects during the Carboniferous period.

Best Known

The cockroach is probably one of the best known and most hated of insects. It is associated by most people as an indicator of filth and unhygienic conditions. The cockroach descends from an ancient lineage of insects which have inhabited our planet for as long as humans. They will outlive humans when it comes to war, and nuclear accidents such as in Japan and in Russia. They are a super intelligent insect and will outwit most of us.

Some 4000 species are recognized today. Of these, only about twelve are commonly associated with humans. 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***". 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.

Cockroaches are the most important insect pests in households and public places. These insects are oval, flat-bodied, dark colored, with chewing mouth parts, three pairs of legs and usually two pairs of wings. 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.

They have well developed compound eyes and very long filiform antennae are found on the head. 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.

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.

Life Cycle
All roaches have three stages in their life cycle -- egg, nymph (young) and adult.

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.

Live Everywhere
Cockroaches can be present in almost any place inhabited by humans. They move quickly and are especially active at night.

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.

German Cockroach

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.

Common Cockroaches in the World

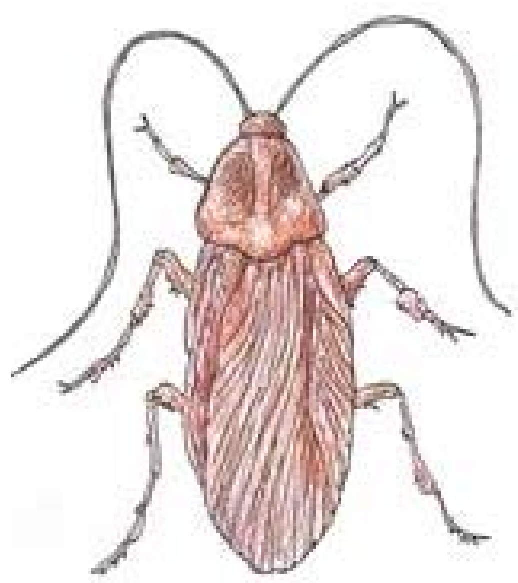
Scientific Classification
Cockroaches make up the order Blattodea, which contains five families.

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.

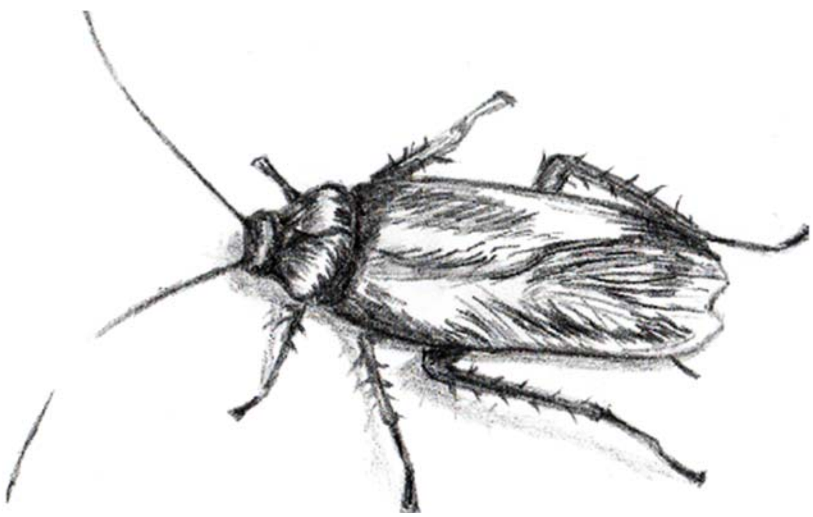
There are 55 species of cockroaches in the United States, but only five of these are troublesome in the most States.



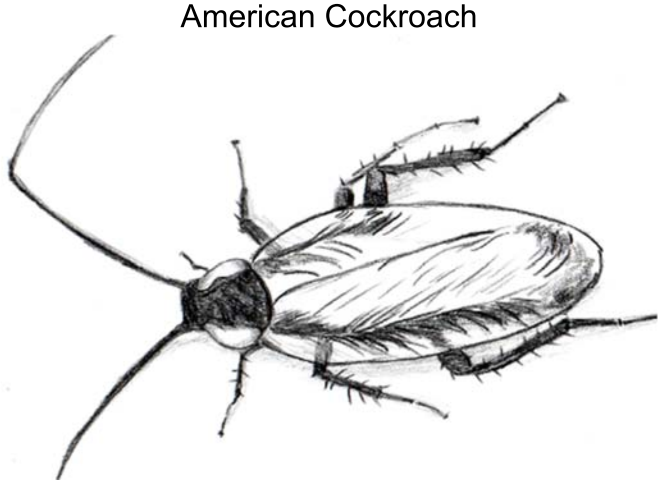
AMERICAN COCKROACH

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



American Cockroach



Wood Cockroach

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.

Common Name: German cockroach

Scientific Name: *Blattella germanica* (Linnaeus)

Order: Blattaria

Description: 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).

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.

Brownbanded Cockroach (*Supella longipalpa*)

Brownbanded Cockroach. Both nymphs and adults of this species (Figure 2) 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.

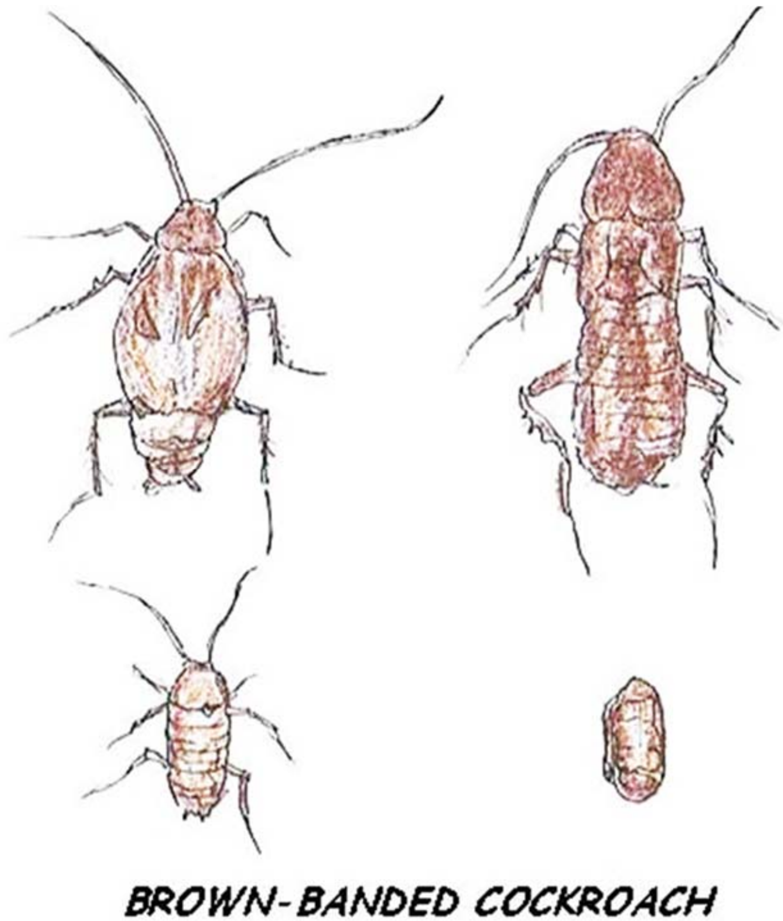


Figure 2. Brown-banded Cockroach. Supella longipalpa (F.)

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.

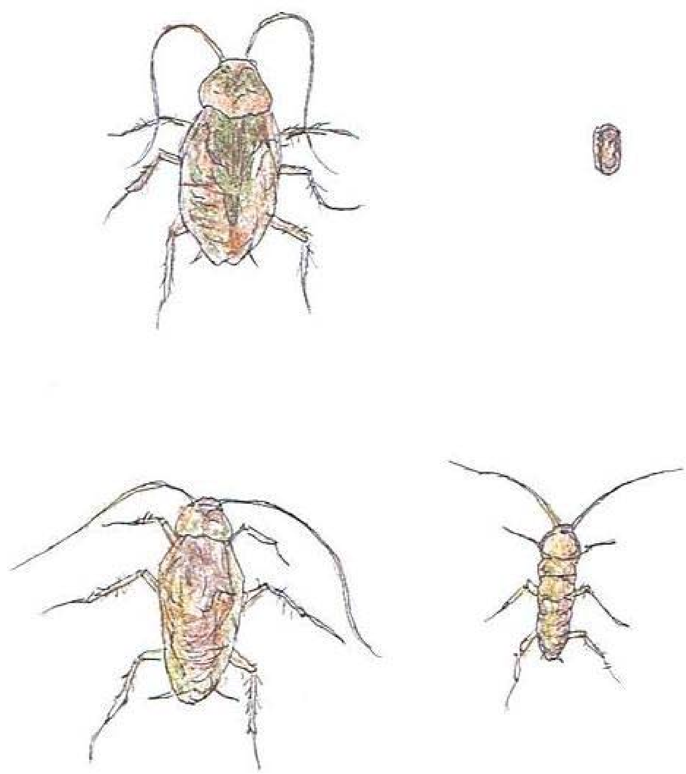
Brownbanded cockroaches prefer a dry, warm environment. They are generally found on ceilings, high on walls, and in light switches, closets and furniture. In some places they are known as "***TV roaches***" because of their frequent presence in living-room furniture and appliances.

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.

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.



AMERICAN COCKROACH

Cockroaches 1 Inch or Larger

American Cockroach (Periplaneta americana)
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.

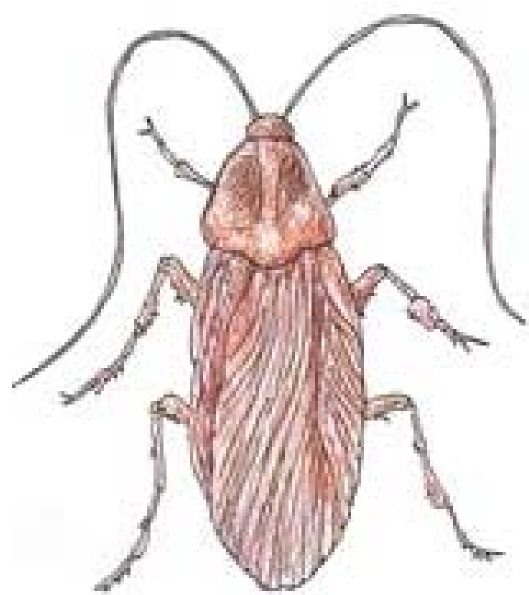
American Cockroach. Adults of this species are 1 1/2 to 2 inches long. They are the largest of all the cockroaches common in the World.

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.

American Cockroach. Periplaneta americana (l.)

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.



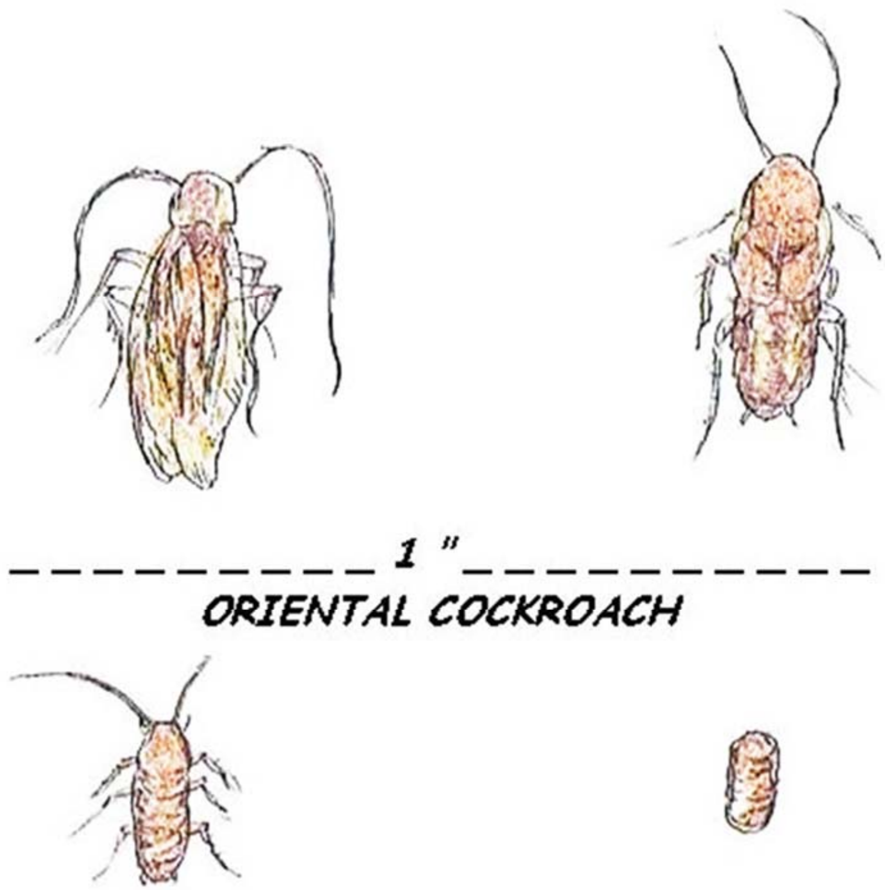
AMERICAN COCKROACH

Oriental Cockroach

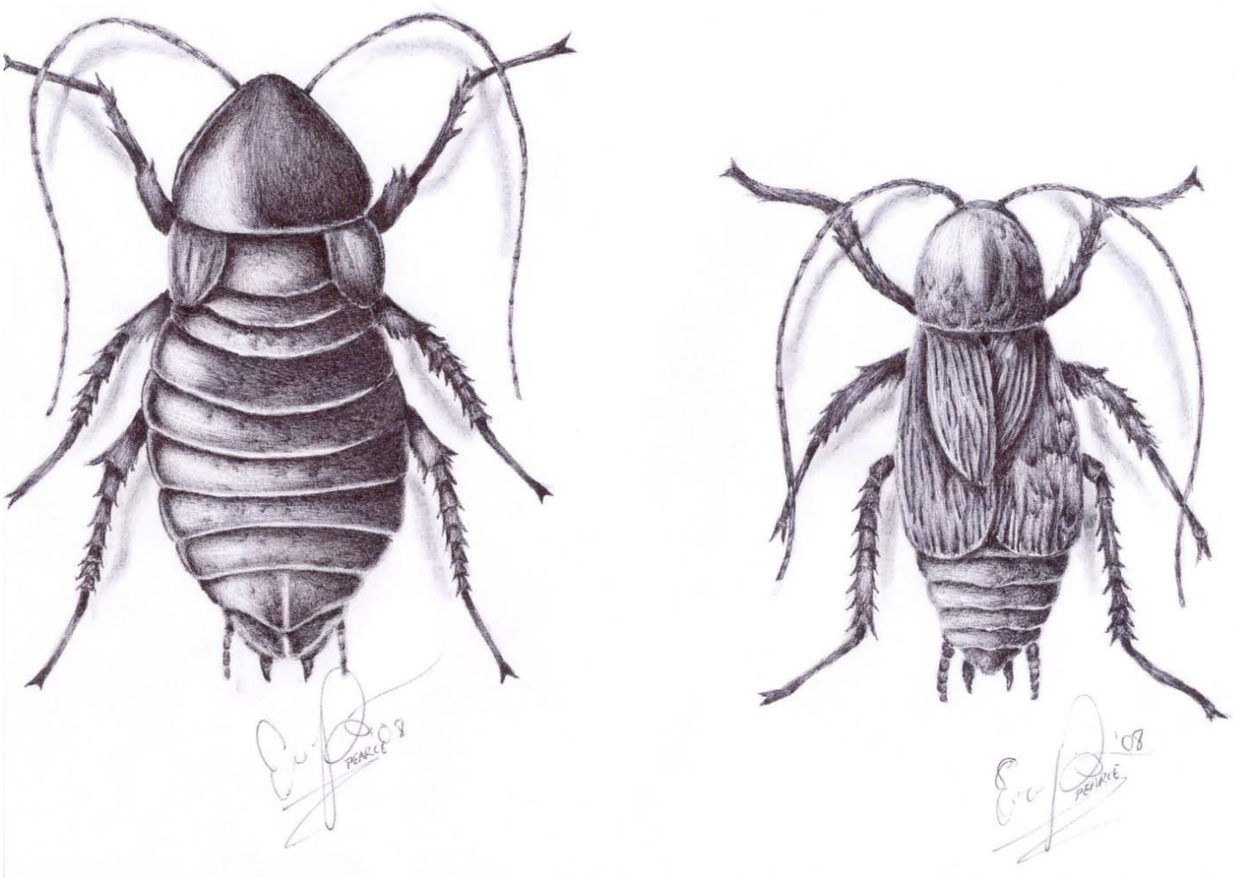
This dark reddish brown to black roach is commonly referred to as the "***water bug***." It is considered the most repulsive of all of the roaches and has a strong odor. The adult females are 1 1/4 inches long and almost wingless. The adult males are 1 inch long and have wings that are about half as 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



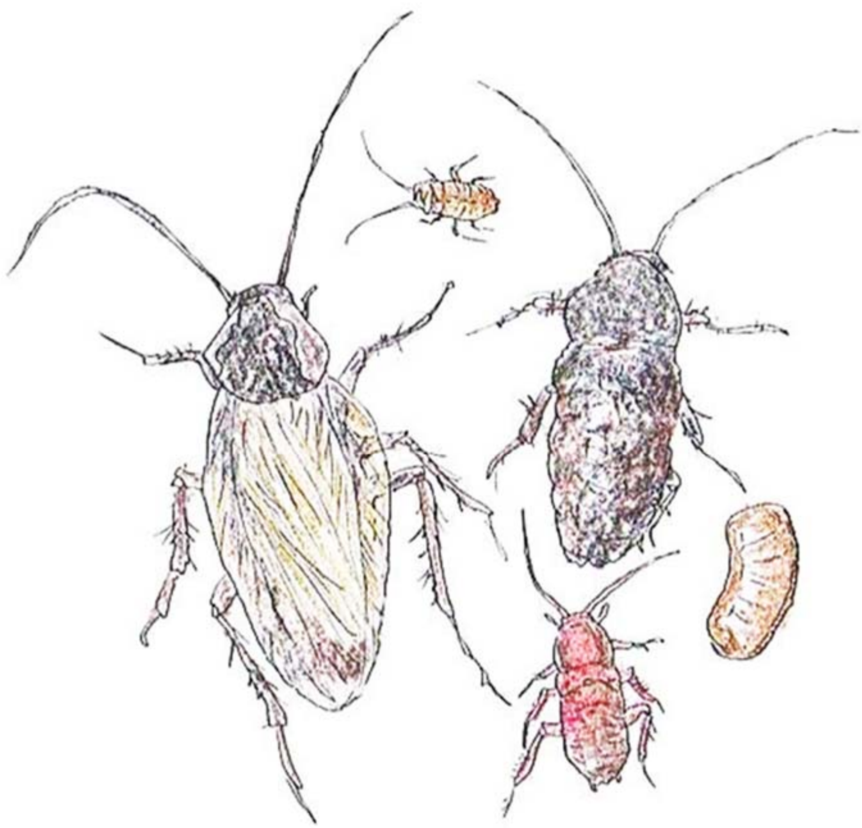
Oriental Cockroach. Blatta orientalis

Wood Cockroach

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.



VARIOUS WOOD COCKROACHES

Smokybrown Cockroach *Periplaneta fuliginosa*

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.

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

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.

Asian Cockroach *Blattella asahinai*

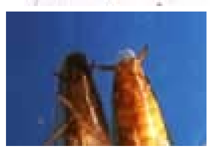
The Asian cockroach was identified as a newly introduced species to the United States in 1986 when a professional pest control operator collected these insects in Lakeland, Florida. He referred to them as German cockroaches, *Blattella germanica* (L.), but noted that their behavior was unlike any other 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.

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.


adult male


wing lengths

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*.


ventral view of egg capsules


dorsal view of egg capsules


early instars


late instars


pronotol stripes

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.

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.

The basic routes for a pesticide or herbicide to enter the body are: inhalation, skin and eye contact, ingestion, and injection. The prevention of entry by one of these routes can be accomplished by control mechanisms such as engineering controls, personal protective equipment, and administrative controls. Each route can be minimized by a variety of control measures depending on the hazard and operation.

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.

Madagascan Giant Hissing Roaches

(*Gromphadorhina portentosa*)

The cockroach family, to which Madagascan roaches belong, is among the most primitive of the winged insects. The nearest relatives to cockroaches include mantids, grass-hoppers, stick insects, and termites (Cornwell 1968). The fossil record shows that roaches were very abundant during the Carboniferous period, 250 million years ago. 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.

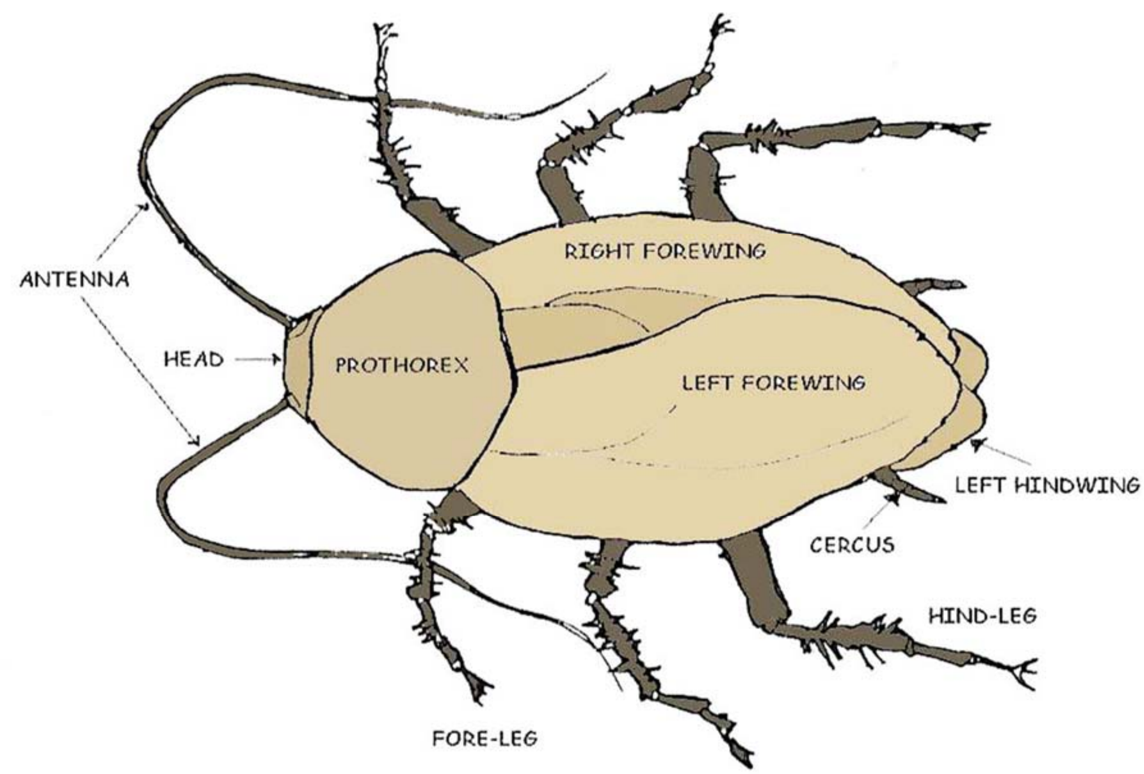
Some, such as the Madagascan roach, do not have wings. About a dozen or so species live commensally in the nests of ants, wasps, or termites. There are also roach species that inhabit caves with bats or live in the desert. The majority of cockroaches in tropical countries exist as scavengers outdoors, 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.



Cockroach Management Strategies

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.

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.

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
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.

Baits
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.

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:

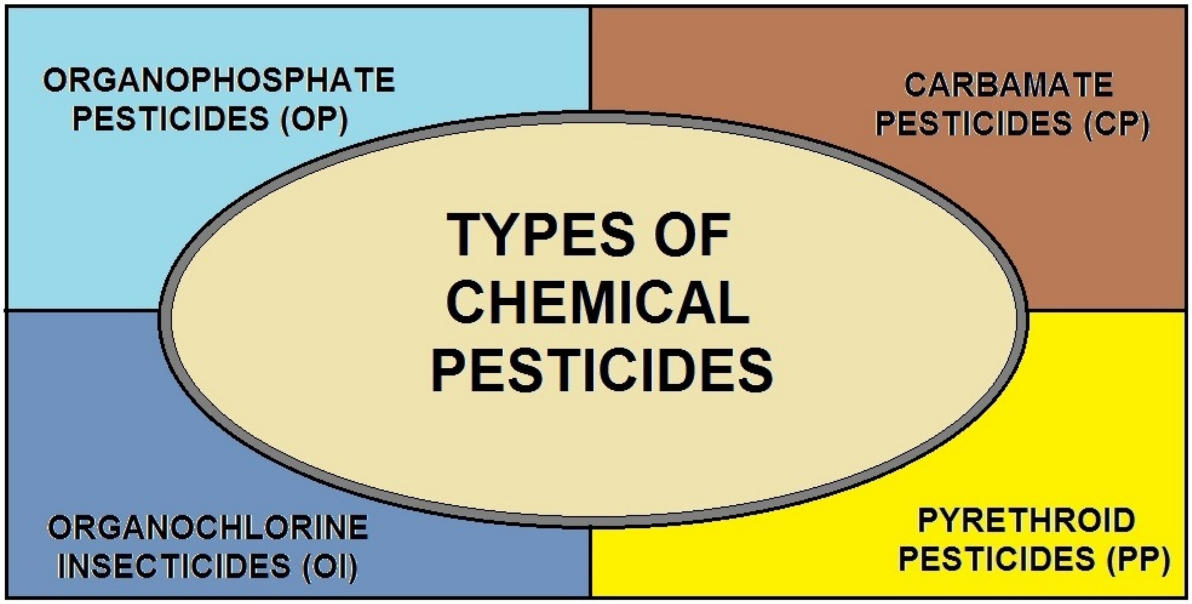
acephate (Orthene®)	permethrin
allethrin	phenothrin
boric acid	propoxur (Baygon®)
chlorpyrifos (Dursban®)	pyrethrins
cyfluthrin	resmethrin
diazinon	sulfluramid
malathion	tetramethrin

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.

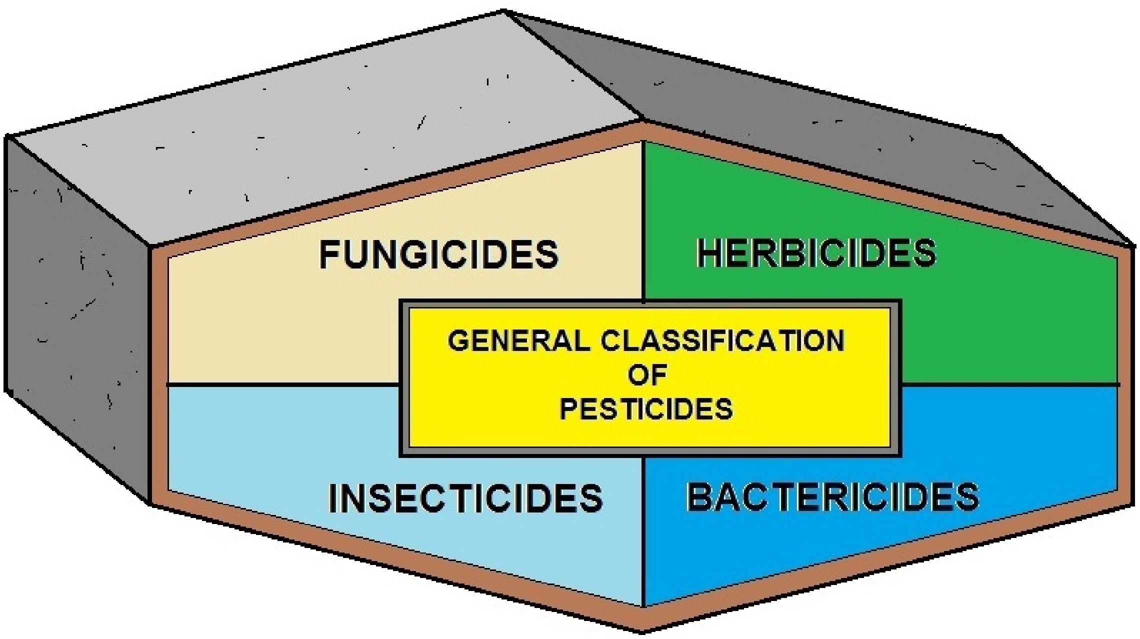
Table 2. Suggested insecticides and formulations for cockroach control.

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.



TYPES OF PESTICIDES



CLASSIFICATION OF PESTICIDES

Insect Growth Regulators

Some synthetic compounds mimic natural hormones found in insects. When applied to cockroaches during their early developmental stages, they cause nymphs to molt into sterile adults. Insect growth regulators (**IGRs**) have low human toxicity, but have long residual effectiveness. For best results they must be applied along with residual insecticides to eliminate existing adults or other non-susceptible stages. Over-all population reduction with IGRs usually takes several months.

Trapping

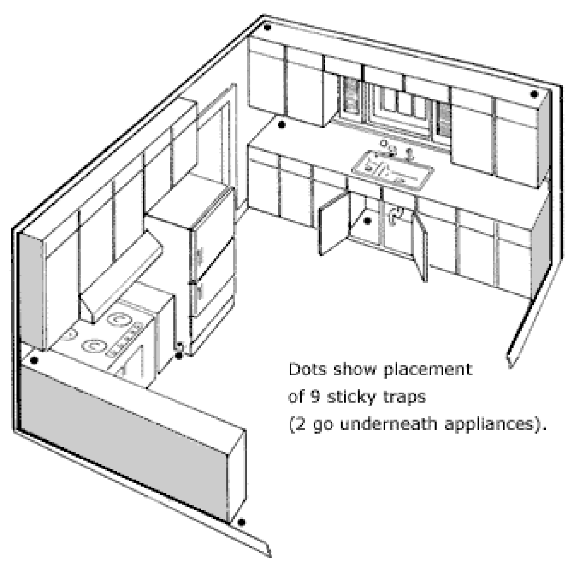
Several types of cockroach traps are commercially available. Traps capture roaches, and are a good monitoring device. While the traps can be useful to reduce light infestations, they do not effectively control heavy cockroach infestations.

Place traps against a vertical surface, preferably a corner, where cockroaches are usually found. They are most effective when placed under sinks, in cabinets, near the kitchen stove or refrigerator, in basement corners or near floor drains.

Roach Traps

Regardless of the treatment method you choose, another tool which can be a great help when treating roach infestations is the use of Roach Traps. These rely on roach pheromones to attract all types of roaches but they work particularly well for German and several of the large roach species. Place them where roaches have been seen. The pheromones will attract males ready to reproduce, females in search of nest sights (the odors emitted signal a roach gathering place or nest) and young roaches which are looking for a colony to mix and mingle.

The great advantage of traps is that they are not toxic; the pheromones are not detectable by people and pose no hazard to food, people or pets. The traps can be placed in pantries, food cabinets, desks, dressers, closets, countertops or anywhere roach activity is present. The second advantage for using these devices is that they are able to let you know where roach activity is greatest. It is common to focus on wrong areas when spraying or baiting and the use of these traps can help identify just exactly where the roaches are located.



By setting two or three in a room which has roach activity, you can learn exactly which part of the room is the "***hotspot***" which needs extra attention. The only disadvantage of these traps is that used alone they will not control most problems.

It is easy to be misled into believing all the roaches being trapped will stop the infestation. Since roaches will be reproducing more rapidly than the traps can catch them, you should not rely on traps alone if you want to get control.

Ideally, they should be used as another tool to help control this pest; using them as a solve-all will certainly keep numbers down but not eradicate existing populations.

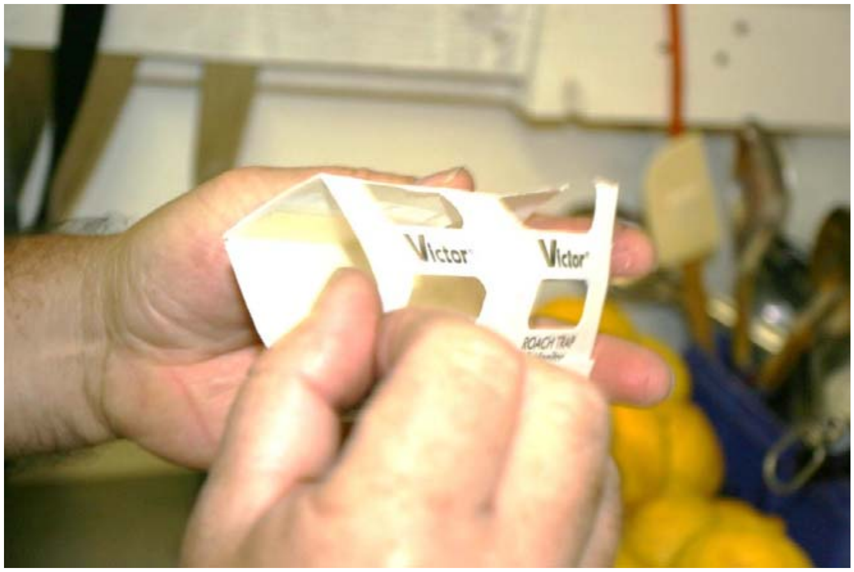
Whatever form of pest control you choose to implement for your home, try to follow these guidelines. Knowledge is essential and with it comes an understanding of why roaches are so hard to control. As difficult as it may seem, you can gain control with patience and persistence. Once control is acquired, preventative maintenance will stop future infestations. In the United States, we have the very best the world has to offer for pest control.

Cypermethrin, Drione and Orthene can control the toughest roach population. Maxforce and Avert are simply irresistible and if used together will eradicate any infestation.

American Cockroaches will be easily found in irrigation and water meter boxes.

Procedures for Cockroach Control in a Restaurant Kitchen

Start with a thorough inspection, i 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 but I am going to tell you my procedure and it works for complete cockroach control. 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. I have placed these everywhere, including on the ceiling. These traps will tell you volumes of data about our friends, tents are great tools. A lot of my procedures are suggestions only and the best rule is to follow the pesticide 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 pest identification is to apply the roach hormone growth regulator and dust all the cracks and crevices with boric acid 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. 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. Always follow the label's instructions.

After the first treatment, return again in 7-10 days and give the roaches the hammer. Return this hammer with a different chemical treatments every six months. On the top, I am using Maxforce Magnum Roach Killer Bait Gel and 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. I also dust with boric acid to add a little extra killing power for those hard to reach roaches. Always follow the label's instructions.

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. Always follow the label's instructions.

Bookeeping 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. Always follow the label’s instructions.

Return every 7-10 days and inspect those 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. 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. Always follow the label’s instructions.

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.

Cockroach Post Quiz

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.

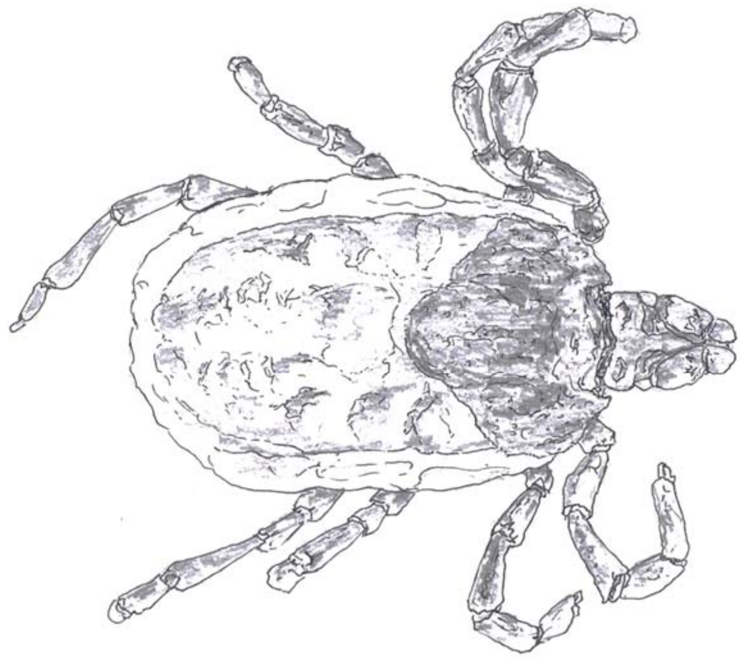
Answers

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

Tick Section

Ticks do not make excellent pets. Ticks are excellent vectors for disease transmission. More than 800 species of these obligate blood-sucking creatures inhabit the planet. They are second only to mosquitoes as vectors of human disease, both infectious and toxic.

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.



HARD TICK

Mites
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.

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 course describes 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.

Feeding
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 them-selves 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 remarkable array of pathogens, such as bacteria, spirochetes, rickettsiae, protozoa, viruses, nematodes, and toxins.

Both warm blooded animals and amphibians are hosts for ticks.

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.

Biology of Ticks

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 described 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.

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.

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. 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.

Soft Ticks

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.

Common Tick habitat, nice brushy and leafy areas**.**

Tick Identification Section

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.

Tick Seed

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*.

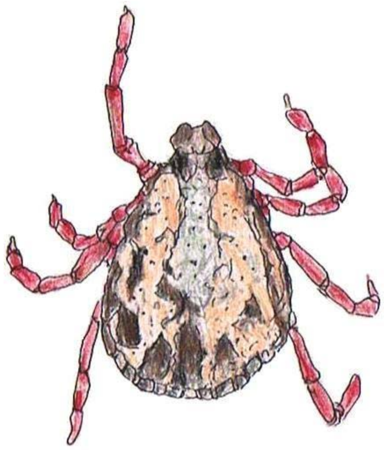
The Bacterium: Even though spirochetes have been seen in *A. americanum* ticks by microscopy, attempts to culture it in the laboratory have consistently failed. Modified BSK (Barbour-Stoenner-Kelly) is the best medium for cultivating the Lyme disease spirochete, *B. burgdorferi*, but is apparently not 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*.

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.

Image: Patient with a classic erythema migrans; 1) site of tick bite, 2) red, radial, expanding edge of rash. 3) central clearing.

LONE STAR TICK

Image: Adult female *Amblyomma americanum* tick.
Note the characteristic "*Lone star*." Nasty creature.

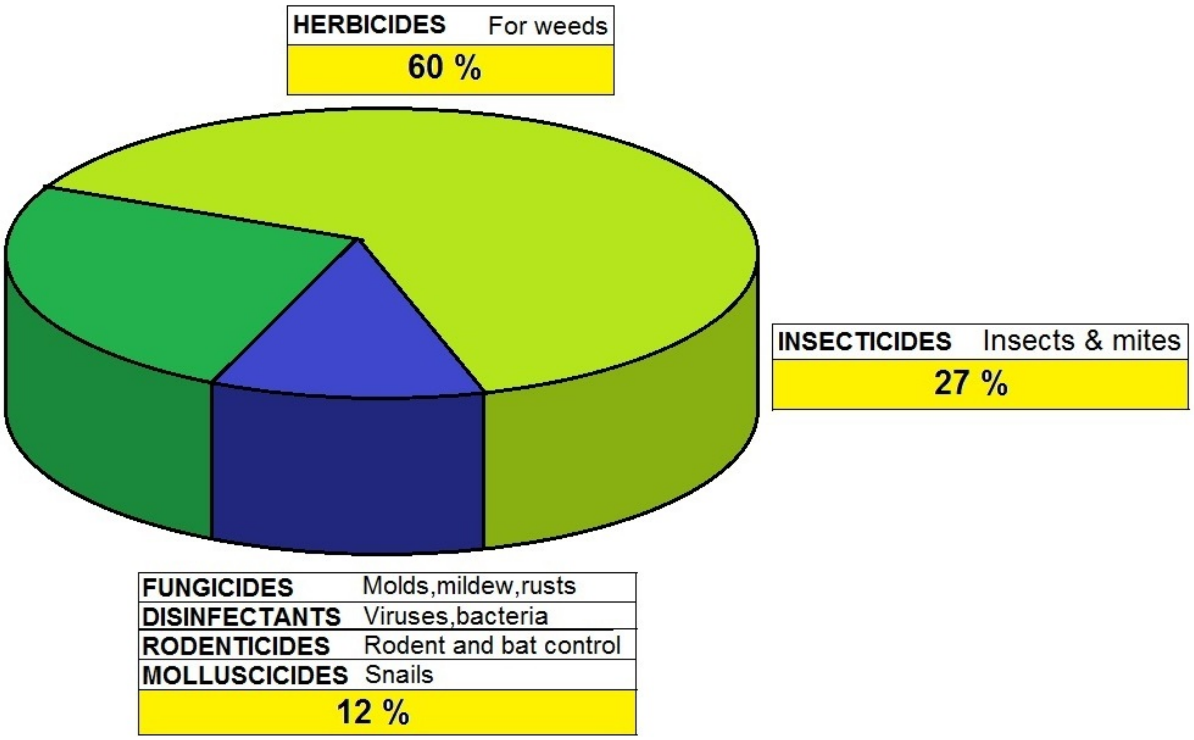


HARD TICK

SOFT TICK

AMERICAN DOG TICK

BROWN DOG TICK



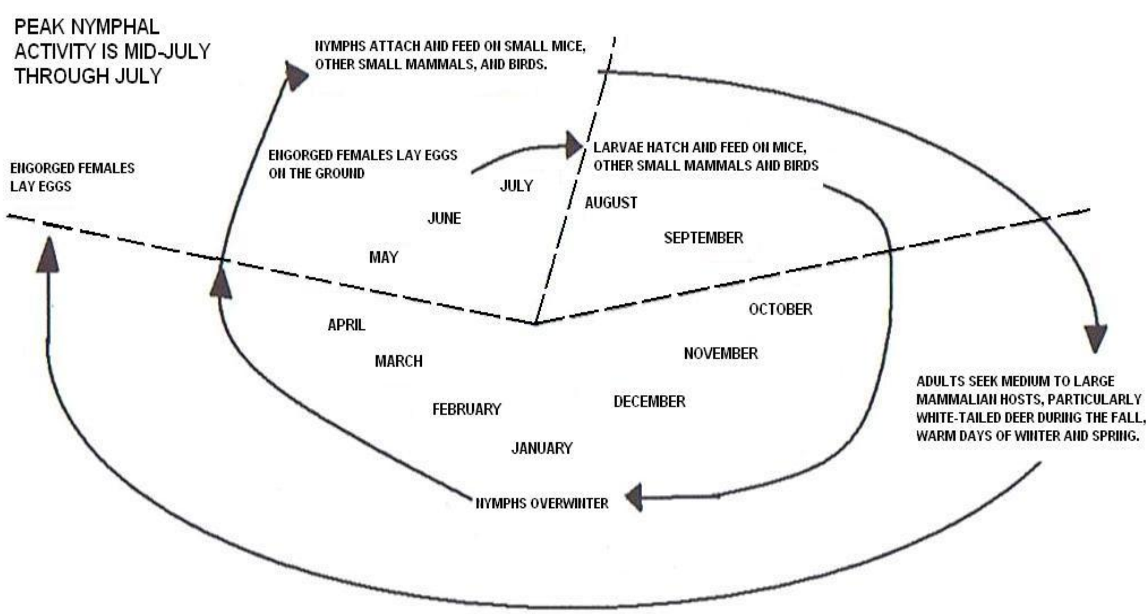
PESTICIDE USE BY TYPE

American Dog Tick *Dermacentor variabilis*

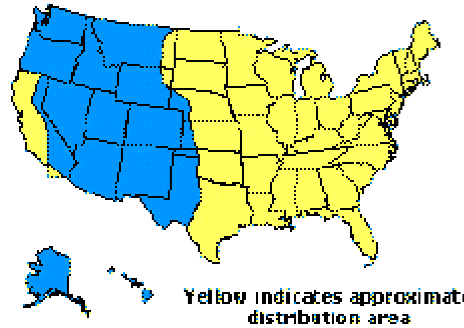
The American dog tick is found throughout the United States except in parts of the Rocky Mountain region. It also occurs in parts of Canada and Mexico. Its habitat includes wooded areas, abandoned fields, medium height grasses and shrubs between wetlands and woods, and sunny or open areas around woods. 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.



Approximate distribution of the American Dog Tick

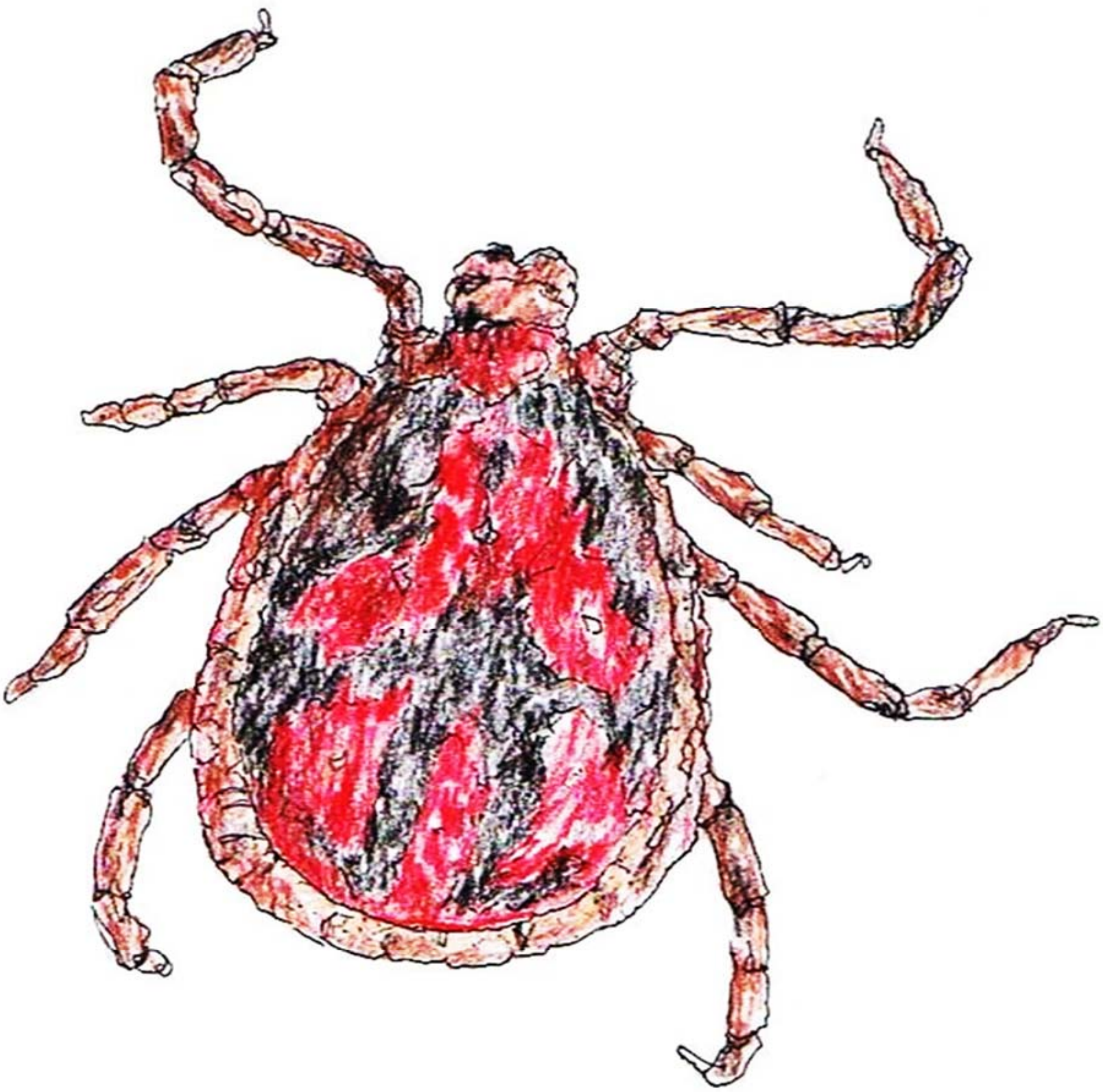


American dog tick (*Dermacentor variabilis*)

AMERICAN DOG TICK

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.

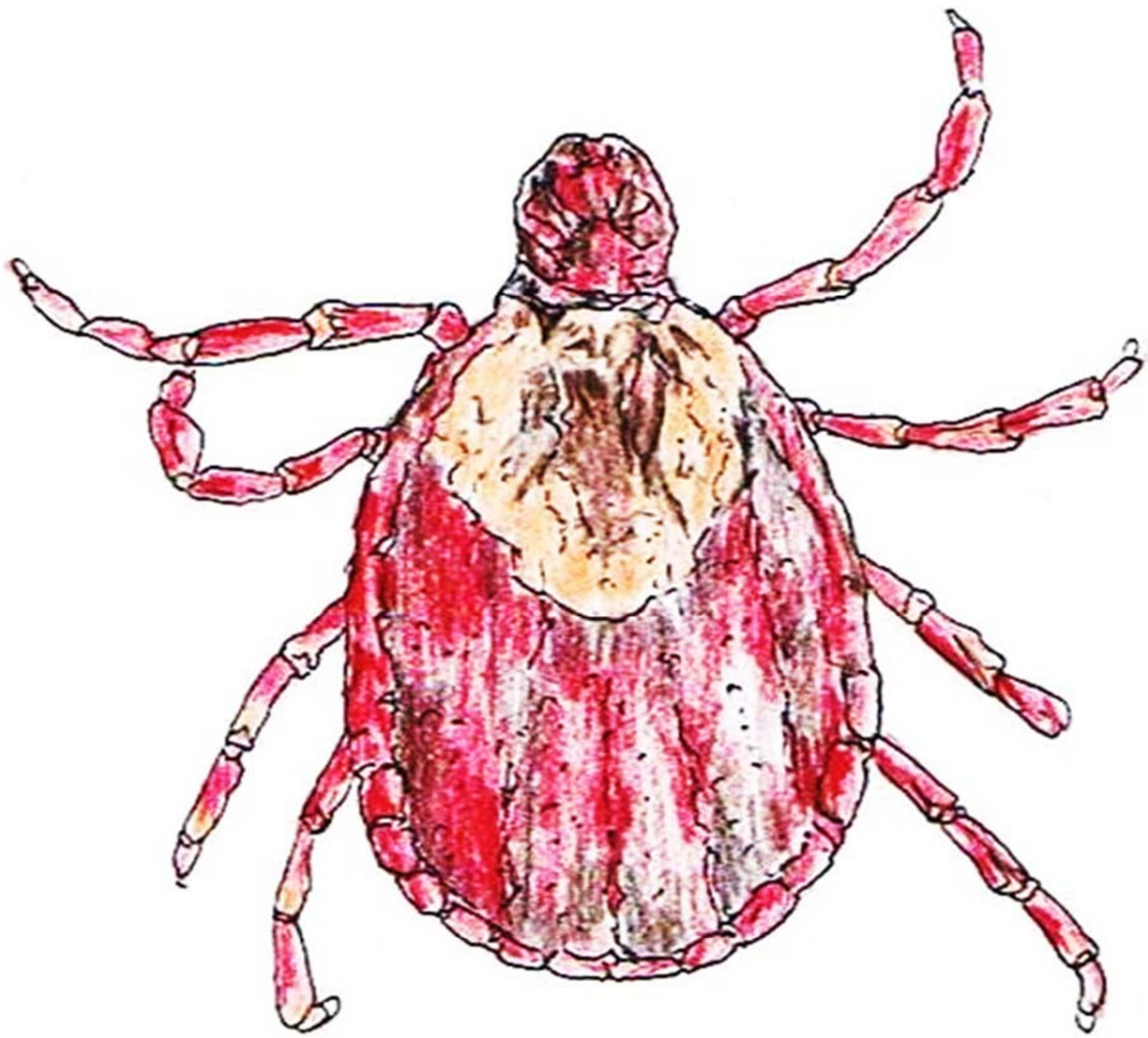
An adult female will feed on the host for around one week, then drop off the host and find a secluded place for egg development. Cracks and crevices in houses, garages and dog runs are ideal locations. She will start laying as soon as four days after she completes feeding and drops off the host, and 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.

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.



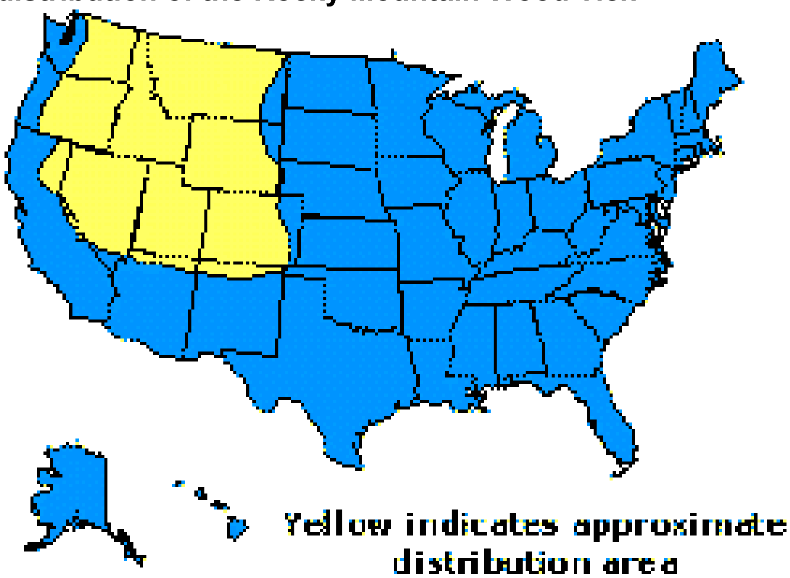
ROCKY MOUNTAIN TICK

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.

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.

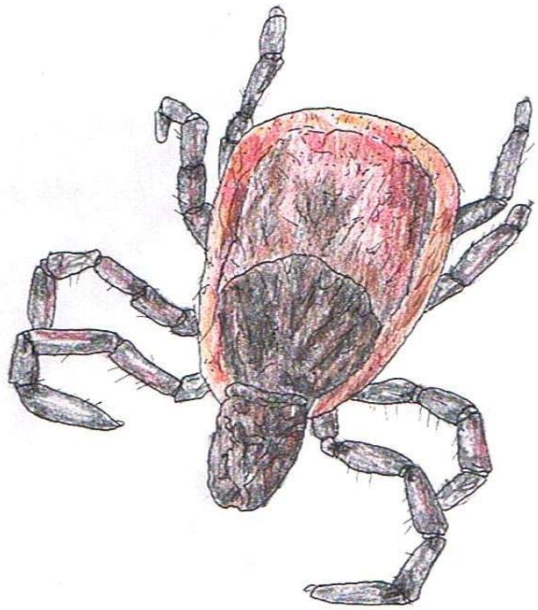
This species is the primary vector of Rocky Mountain spotted fever in the Rocky Mountain States and is also known to transmit Colorado tick fever and Tularemia. It also carries tick paralysis in the United States and Canada.

Approximate distribution of the Rocky Mountain Wood Tick



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.

Deer Tick Ixodidae *Ixodes scapularis*



DEER 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.

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. 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.

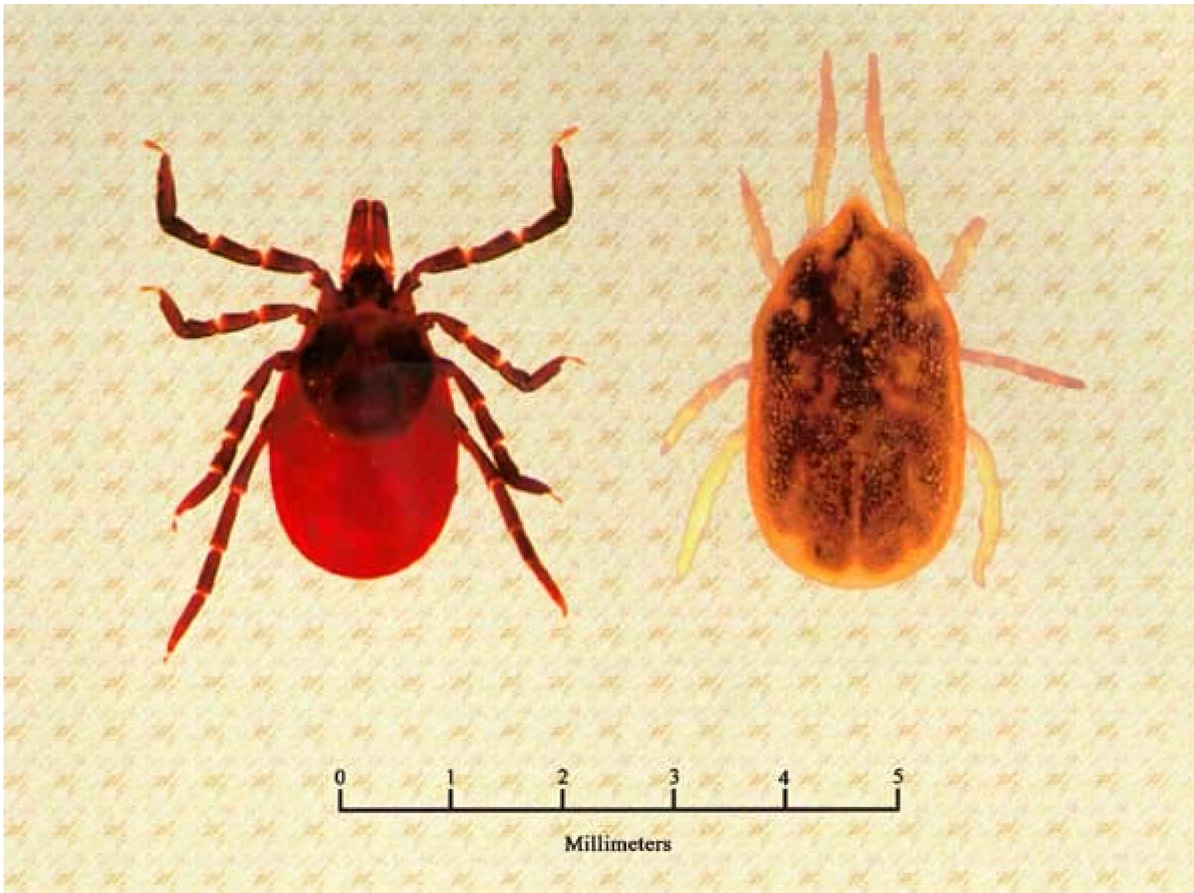
Stage 2: Nymph - Most larvae, after feeding, drop off their hosts and molt, or transform, into nymphs in the fall. The nymphs remain inactive throughout the winter and early spring. In May, nymphal activity begins. Host-seeking nymphs wait on vegetation near the ground for a small mammal or bird to approach. 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.

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.

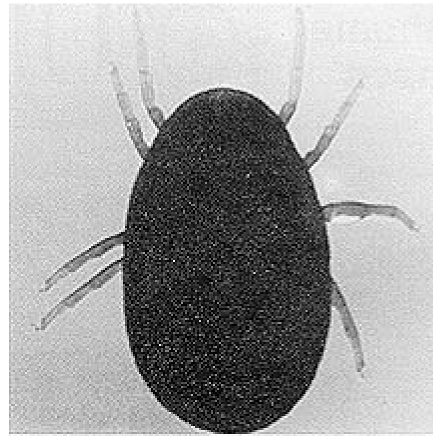
Who gets Relapsing Fever?
Anyone can get relapsing fever that is bitten by an infected tick. Most cases in North America are reported in the western U.S. and Canada.

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.

Fowl Tick *Argas persicus*



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.

Spinose Ear Tick *Otobius megnini*

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.

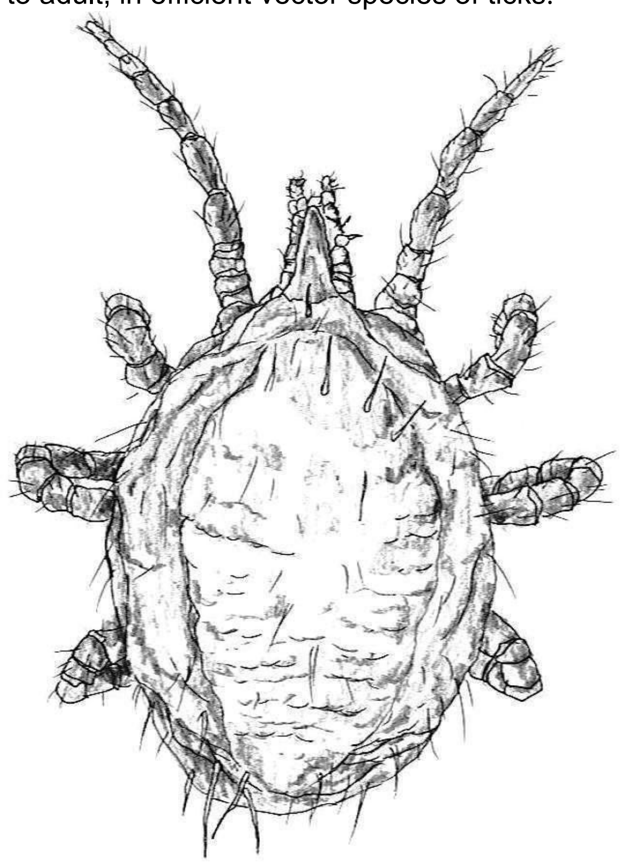
Spinose Ear Tick

SPINOSE EAR TICK

Spinose Ear Tick ***Super Nasty***
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.



FOWL MITE

Rodent Tick *Ornithodorus hermsi*

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

Winter Tick *Dermacentor albipictus*

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.

Partially Fed Adult Winter Tick Removed From a Horse

Pacific Coast Tick *Dermacentor occidentalis*

The Pacific Coast Tick is a three host tick which commonly feeds on rodents, especially squirrels, as subadults, 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).

Deer Tick *Ixodes scapularis*

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).

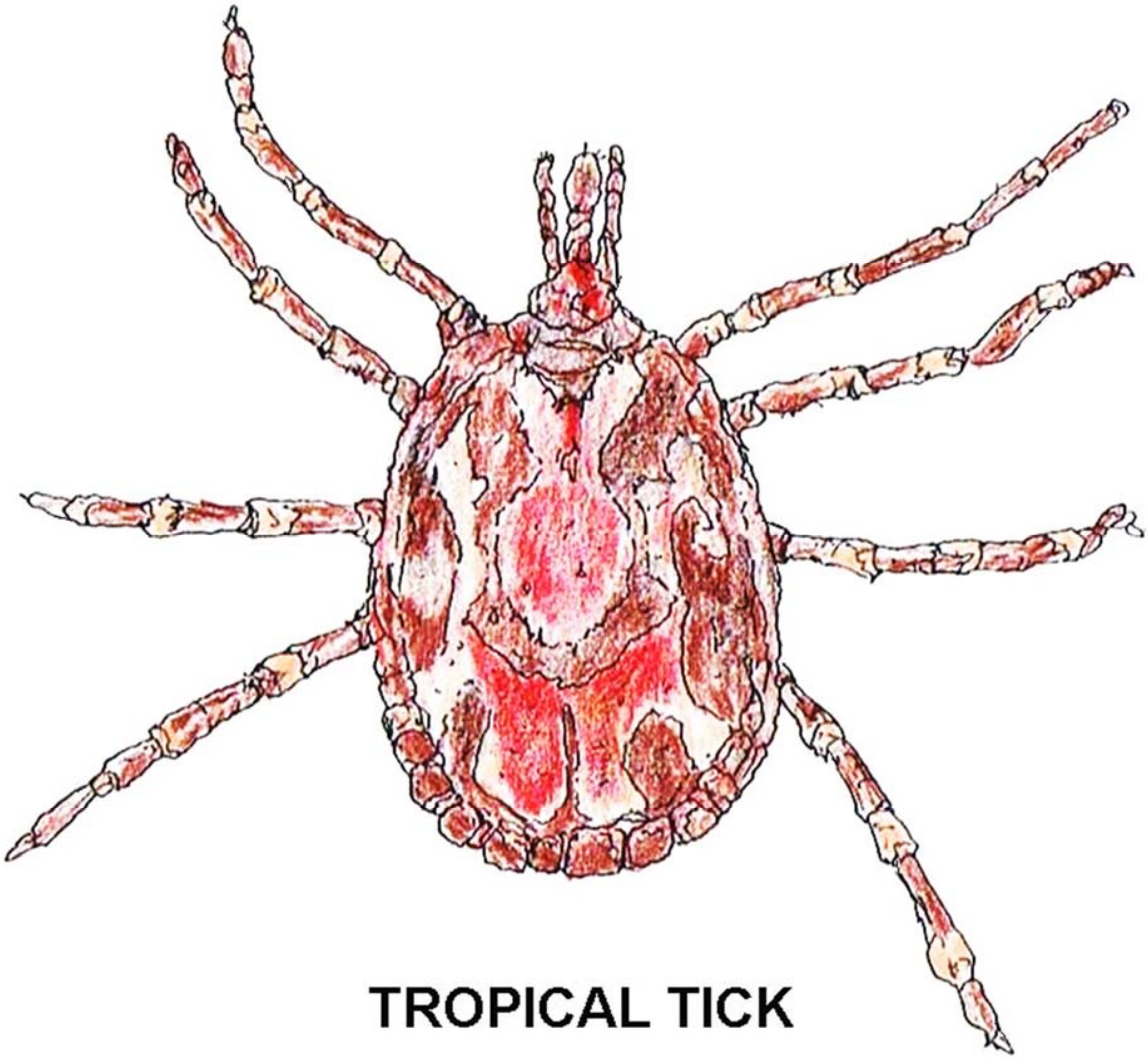
Distribution is associated with high humidity and mild mean winter temperatures. However, it is not restricted by winter temperatures, as areas of tick activity occur in Minnesota and Wisconsin. The requirement for high humidity restricts this tick from spreading to arid regions and high mountains where 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.

Male deer tick
Ixodes scapularis.

Tropical Tick *Amblyomma Species*



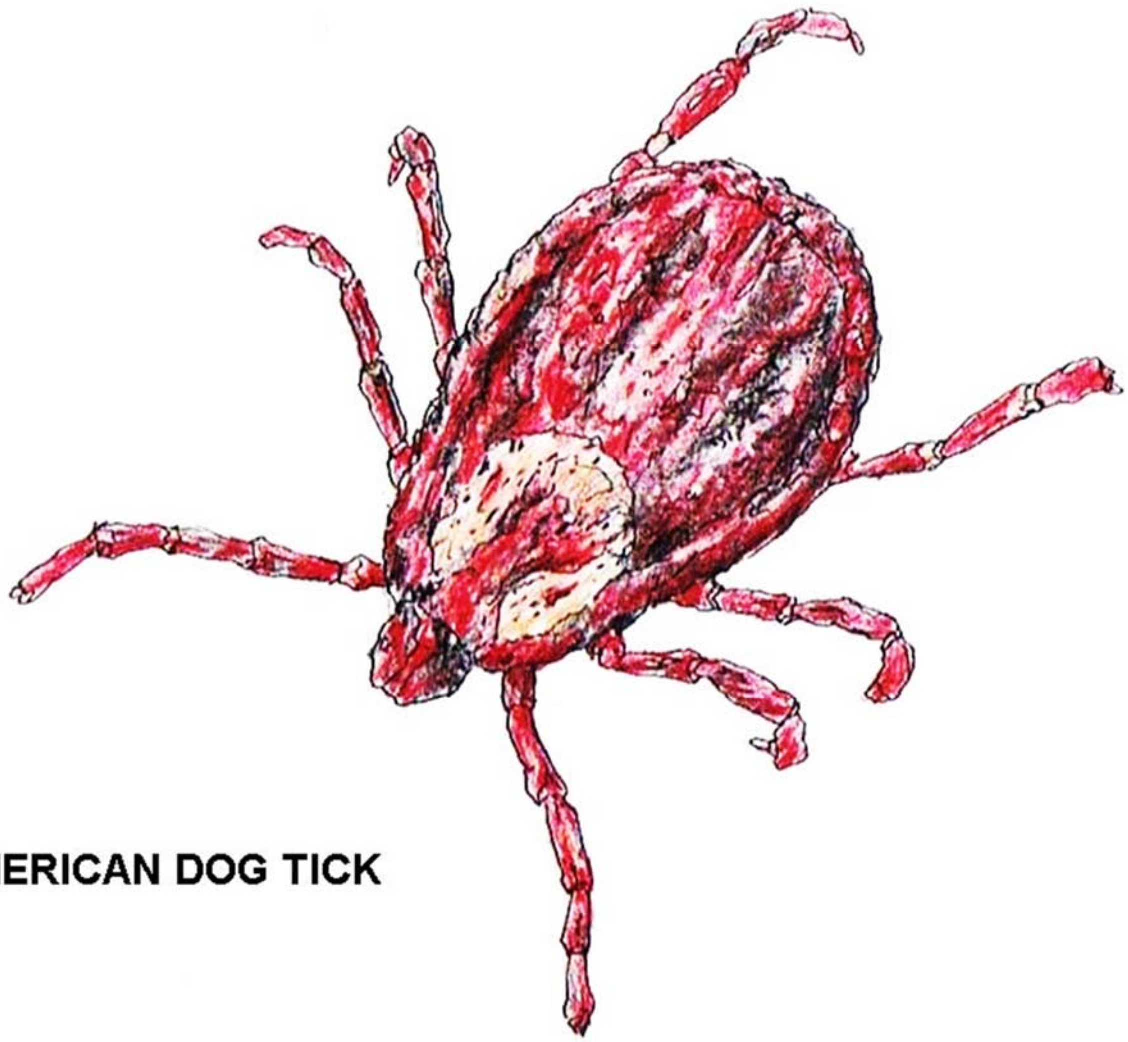
TROPICAL TICK

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.



AMERICAN DOG TICK

Medical Effects of Ticks

Tick-borne diseases include: Rocky Mountain Spotted Fever, Tularemia, Lyme Disease, Colorado Tick Fever, Ehrlichiosis, Relapsing Fever, Q Fever, and Babesiosis.
Prevention of all tick-borne diseases can be divided into several strategies. These are environmental, personal, and prophylactic (after the tick bite has occurred).

- Environmental strategies (control of the population of deer and other vectors and tick control measures) are beyond the scope of this section.
- Personal strategies include avoiding grassy areas with shrubs that attract ticks, wearing white or light-colored clothing so that attached ticks can be seen easily and removed, tucking pant legs into socks, walking in the center of paths to avoid vegetation on which ticks lie in wait of a host, applying lotion containing diethyltoluamide to the skin (avoiding face and hands), applying permethrin to clothing, and performing daily tick checks and removing ticks as soon as they are detected.
    - Diethyltoluamide concentrations of about 30% are recommended; neurotoxicity (e.g., seizures) is reported in children, and some authorities recommend avoiding repeated use in children.
    - Tick removal is best accomplished by grabbing the tick as close to the skin as possible with a very fine forceps and pulling it gradually, but firmly, out from the skin. Gloves should be worn when removing ticks and the bite site should be thoroughly disinfected with alcohol or another skin antiseptic solution. Care should be taken to avoid squeezing the tick during removal, since squeezing may inject infectious material into the skin. Use of gasoline, petroleum, and other organic solvents to suffocate ticks, as well as burning the tick with a match, should be avoided. Often, the complete mouthparts do not come out with the rest of the tick. Leaving these in does not increase the risk of disease transmission, but they may cause a local infection or foreign body reaction.
- Prophylactic measures include the use of vaccines, which are available for some tick-borne diseases and are discussed in the individual sections.

Paralysis
Ticks may cause paralysis in humans that is reversible when the ticks are removed. Symptoms include paralysis of the arms and legs, followed by a general paralysis which can be fatal if not reversed. The victim may recover completely within a few hours of the removal of the tick. The paralysis may be caused by a salivary toxin transmitted to humans when a tick feeds.

Tick paralysis is frequently associated with the attachment of the tick at the base of the victim's skull; however, the illness occurs from attachment to other parts of the body as well. The highest incidence of tick paralysis in North America occurs near the border of British Columbia, Canada, and the northwestern United States.

The two most important tick-borne diseases in the United States are Lyme disease and Rocky Mountain spotted fever. The onset of Lyme disease is usually characterized by the development of a large, red rash which may develop a characteristic clear central area ("*bulls eye*"), one to two weeks after a tick bite, often in the area around the puncture. Other symptoms include joint pains, flu-like symptoms, and neurological or cardiac problems.

Rocky Mountain Spotted Fever

The most characteristic symptom of Rocky Mountain spotted fever is a rash on the ankles, wrists, and forehead one to two weeks after the victim is bitten. The rash spreads to the trunk and is accompanied by fever, chills, and prostration. Both Lyme disease and Rocky Mountain spotted fever are transmitted after the tick feeds for several hours. Prompt removal of attached ticks greatly reduces the chances of infection.

Tick bite “Bull’s Eye”. Can you identify this bite?

Both diseases are usually successfully treated with antibiotics in their initial stages. Therefore, early diagnosis is imperative. For this reason, it is recommended that the date of a tick bite be marked on a calendar. If unexplained disease symptoms occur within two to three weeks, a physician should be consulted.

Removal of Ticks

The best means to prevent the transmission of tick-borne diseases and the development of tick paralysis is the prompt removal of ticks. This requires regular inspection of clothing and exposed skin for attached or unattached ticks.

To remove a tick, grasp it crosswise with narrow tweezers (do not rupture the tick) as close to the point of attachment as possible. Retract or pull tick firmly in the direction of attachment; some back-and-forth wiggling may be necessary.

Do not twist or rotate the tick. Do not handle ticks with bare hands because infectious agents may enter through mucous membranes or breaks in the skin. Removed ticks should be immersed in alcohol to kill them. Disinfect the bite site and wash hands thoroughly with soap and water.

The diseases listed above can be fatal. Any case of such a disease should be reported to medical authorities immediately. Frequent or multiple reports of tick-borne diseases should be reported to a public health service representative. The representative can recommend actions to control disease outbreaks.

Endemic Relapsing Fever

Another important tick-borne disease is endemic relapsing fever. This disease is limited to the western states and is caused by a spirochaete carried by certain ticks in the genus *Ornithodorus*. These ticks are found on tree squirrels (*Sciurus* spp.) and western chipmunks (*Eutamias* spp.).

The disease can also be transmitted directly to the tick's offspring. These ticks usually live three to five years. Humans are at increased risk of contracting endemic relapsing fever when they sleep in dwellings that have become inhabited with infected squirrels or chipmunks. As with sylvatic plague, the rodents vacate the building or are killed by the humans who use the buildings. The ticks which remain behind feed on the people using the buildings. Implementation of exclusion efforts will reduce the incidence of ticks.

Lyme Disease

Ecology and Environmental Management of Lyme Disease
Lyme disease (transmitted by the bite of a tick) is caused by a spirochete, a corkscrew-shaped bacterium which can travel through the bloodstream. The disease is easily diagnosed and treatable in an overwhelming majority of cases.

Ixodes scapularis, tick vector for Lyme disease.

Early Symptoms
Early symptoms of Lyme disease can be mild and easily overlooked. A reddish rash called erythema migrans occurs 60-80% of the time, most often at the site of the bite. Flu-like symptoms, chills, fever, and fatigue are often experienced, but they may not seem serious enough to require medical attention. Later symptoms may include severe headaches, arthritis and nervous system or cardiac abnormalities.

Because it takes 24-48 hours for a feeding tick to transmit the Lyme disease bacteria, examine yourself and your children while outdoors, when you get home, and again at night. As it takes several hours for a tick to attach itself to your body, taking a shower with a washcloth will help wash loose ones off. If you find an attached tick, use a pair of fine-tipped tweezers; grasp the tick as close to your skin as possible, and pull outward gently but firmly.

Mouth parts of adult ticks may sometimes remain in your skin, but these will not cause Lyme disease. After removal, apply an antiseptic such as alcohol or an antibiotic ointment. Do not apply mineral oil, petroleum jelly, heat, or anything else to remove the tick. Redness at the site of a tick bite does not mean you are infected - a true Lyme disease rash usually lasts 2-3 weeks and often increases in size during that time.

Do not try to pull a tick off with your fingers, as this may cause the tick to inject bacteria into your body. Contact your physician if any symptoms of Lyme disease occur, especially if you know you've been bitten by a tick or live in an endemic area.

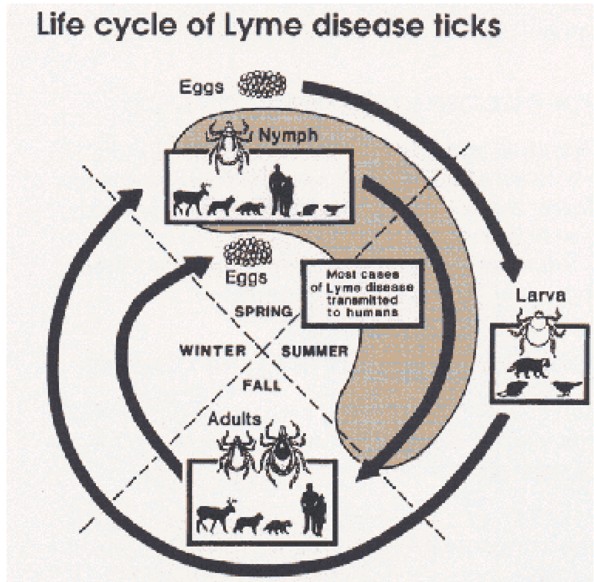
Life Cycle of a Tick
The Life Cycle of a Tick is correspondent to the seasons, with most cases of Lyme disease occurring in the spring or summer when the ticks are in the nymphal stage. This is the most opportune time for ticks to transmit this disease because they are quite small and thus hard to detect when attached to a human. Also, it is during the spring and summer months that humans are most active and most likely to be in environments where ticks are found.

The life cycle of Lyme disease is quite complex and is made up of many steps (5):

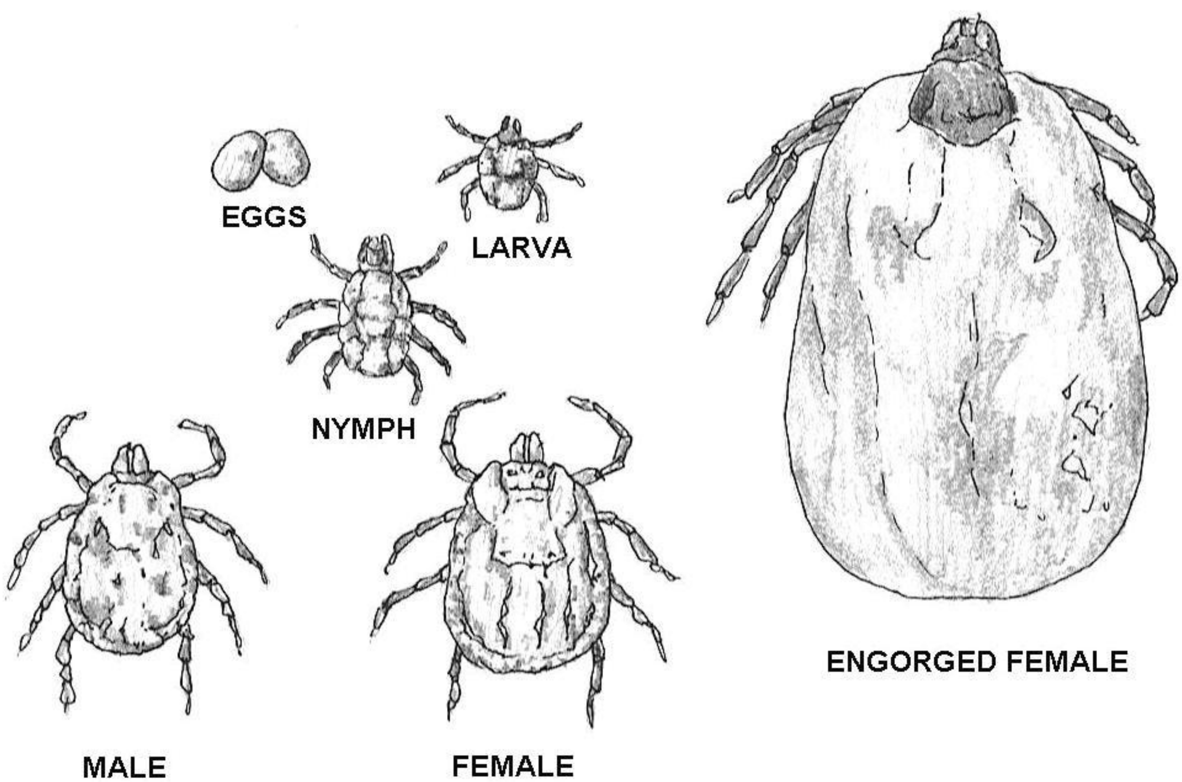
- The life cycle of ticks requires 2 years to complete
- In the fall and early spring adult male ticks feed on large animals such as deer
- Female ticks lay eggs on the ground so that by summer the eggs hatch into larvae
- These larvae then feed on mice and birds in the summer months
- Through early fall these larvae are inactive until they molt into nymphs in the next spring
- These nymphs then feed on mice or birds in the spring and summer molting into adults in the fall to complete the 2-year life cycle

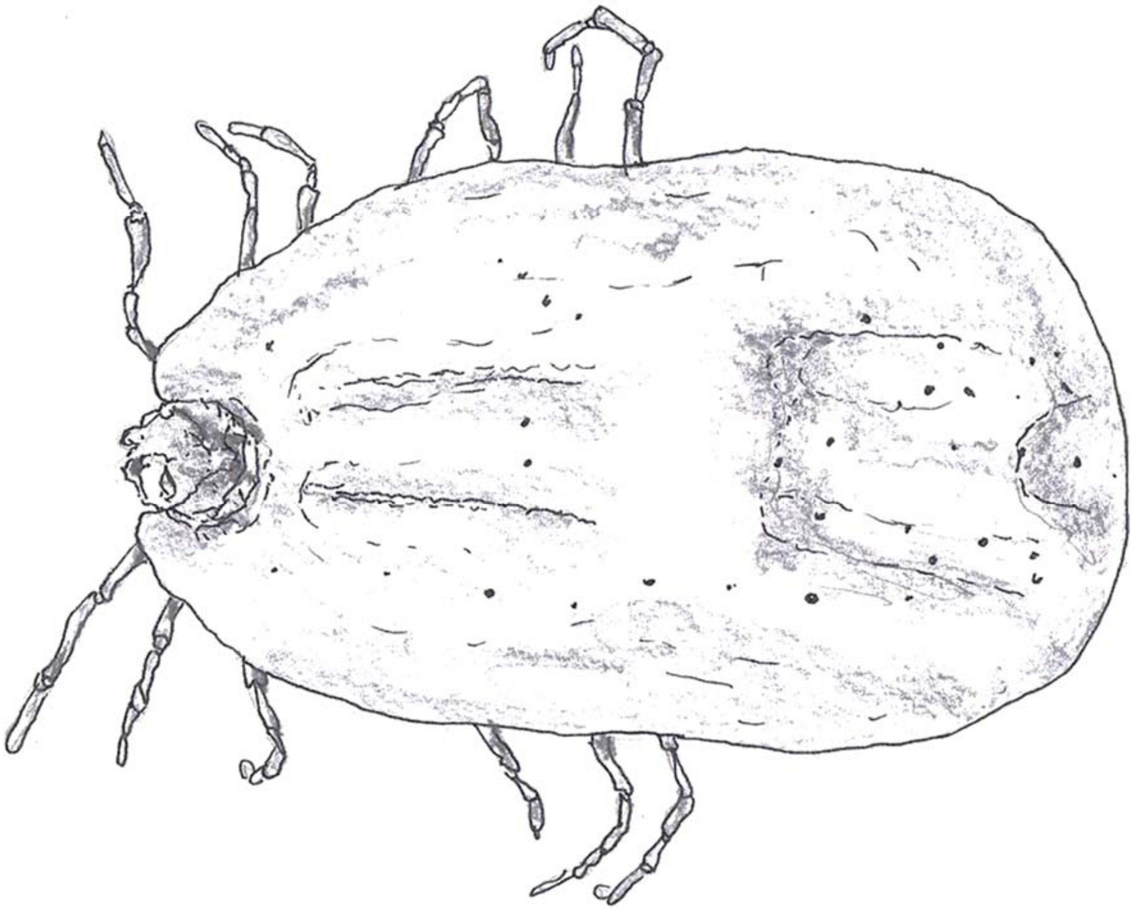
Infection usually occurs when the larvae and nymphs feed on mice and birds that are infected with Lyme disease. Once contracted, this disease stays with the larvae and nymphs as they molt and grow. The infected ticks then naturally transmit Lyme disease as they feed on other animals and humans.

Diagram below is a flow chart describing the life cycle of ticks that carry Lyme disease.



Below is a drawing detailing the different stages and sizes of ticks.





SOFT TICK

You CAN Reduce Your Risks for Lyme Disease...

Before Going Into Tick Habitats:

- Wear light-colored clothing.
- Tuck shirts into pants and pants into socks.
- Apply tick repellent to your skin or clothing, carefully following manufacturer's directions.

DEET-containing repellents (such as Off®, Cutter® or Skintastic®) are effective when applied to skin or clothing. For adults, products with no more than 30% DEET are recommended. For children, use products with a lower percentage; do not use on hands and face, and avoid overuse.

PERMETHRIN-containing repellents (such as Duranon®) are for use on clothing only and are highly effective for up to two weeks after a single application. For both of these products, follow directions carefully.

While Outside:

- Whenever possible, avoid common tick habitats (leaf litter, plant debris, wooded areas, etc.).
- If hiking on trails, stay to center of paths.
- Do periodic tick checks.

Upon Return:

- Carefully check clothing, skin and hair for ticks.

Daily:

- When showering or at bedtime, do a full body inspection for rash or attached ticks. Remember to pay special attention to favorite 'tick spots' such as backs of knees, groin, waist, armpits, scalp and folds in skin.

For Your Pets
Because dogs and cats can also develop Lyme disease, fit your pets with tick collars or treat them with a repellent product applied monthly to the skin. Speak to your veterinarian about this and other options. Frequent tick checks should also be done to find and remove ticks promptly.

Remove Ticks the *SAFE WAY*

DO:

GRASP tick as close as possible to the skin, using tweezers.
PULL straight out with a steady motion.
WASH site thoroughly with soap and water.
RECORD site of attachment and date of bite on calendar.
WATCH for early signs and symptoms of Lyme disease (for up to one month), such as:

Expanding red rash (at least 2" in diameter)

- 'Flu-like' symptoms (fatigue, muscle aches, fever, headache)
- Joint pain and swelling

DON'T:

BURN tick with a match.
SMOTHER with petroleum jelly or noxious chemical.
CRUSH with fingers.

THESE METHODS INCREASE YOUR RISK FOR LYME DISEASE
DAILY TICK CHECKS REDUCE YOUR RISKS!!
Because of their small size, nymphal ticks can easily go unnoticed. A thorough and careful '***Daily Tick Check'*** is the best way to make sure ticks are found and removed promptly.

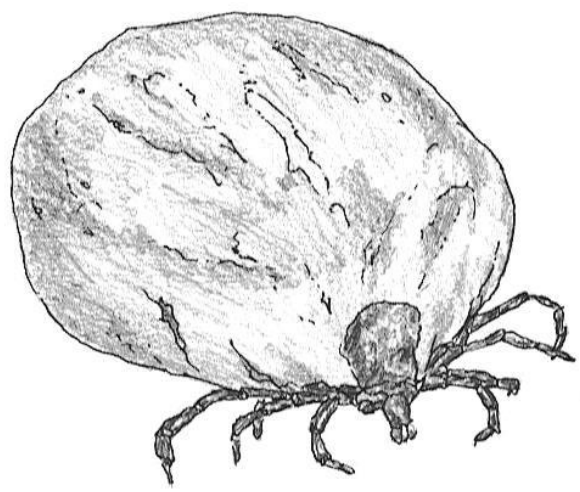
Check your entire body, especially places where ticks are likely to attach, such as the back of knees, groin area, waist, armpits, scalp and folds in skin. While in tick habitats, more frequent checks of clothing and exposed skin are recommended.

Recognize Tick Habitats Around the Home

Use this checklist to identify areas around your home where ticks may be found.
Deer ticks require a damp, humid environment to survive.

Wooded Areas:
Woods are the most common deer tick habitat.
Leaf Litter and Plant Debris:
Humid conditions commonly found under leaf litter and plant debris provide an ideal living environment for ticks.
Overgrown Fields and Hedgerows:
These provide a suitable habitat for both ticks and their hosts.
Ground Cover Areas:
Examples include ivy, pachysandra, etc.
Edges where lawn meets any of the above.

Do any of the above environments exist around your home? If so, here are a few recommendations to help reduce your risks:
MODIFY your environment by cutting lawns and pruning overhanging vegetation to allow in plenty of sunlight. Remove leaf litter and plant debris on a regular basis.
REDUCE the number of ticks on your property by up to 90% through proper use of pesticides. (See Use of Pesticides for Tick Control for details.)



ENGORGED FEMALE

Knowing that small rodents, like the white-footed mouse, and birds are common hosts for ticks…
RECOGNIZE that old fallen trees, stone walls and wood piles provide a home for rodents.
CONSIDER moving bird feeders away from activity areas, as dropped seed often attracts small rodents.

Use of Pesticides for Tick Control

Chemical Control of the tick population in your yard can be very effective if properly timed and targeted. A single application of a granular or liquid pesticide between mid-May and mid-June can kill over 90% of nymphal ticks - those most likely to transmit Lyme disease. Treat only the areas of your property where ticks are likely to be found and follow manufacturer's directions carefully.

If using a professional pest control company, confirm that:

- Applicator is knowledgeable about deer tick control.
- Application is properly timed.
- Treatment is targeted to regularly used, high-risk areas.
- Products being used are labeled for tick control.

Precautions regarding applications are reviewed and followed.
If you prefer to do it yourself:
Granular products - the type most easily applied by homeowners -should be applied to regularly used, high-risk areas.
Apply product with a hand-held or chest-mounted lawn seeder / spreader (inexpensive and readily available at garden supply stores) and use only pesticides labeled for tick control.

Diagnosis and Treatment

The diagnosis of Lyme disease is based primarily on signs and symptoms. Blood tests may be necessary when no rash is present.

- Physicians are experts in diagnosing and treating Lyme disease.
- Lyme disease is most effectively treated when diagnosed early.
- Most patients who are treated for 3 - 4 weeks with a standard antibiotic such as amoxicillin or doxycycline completely recover from Lyme disease.
- You **CAN** get Lyme disease more than once.
- The Urine Antigen Test is NOT an acceptable test for diagnosing Lyme disease.

REMEMBER:

- An estimated 75% of Lyme disease cases are contracted around the home.
- In most cases, a tick must be attached for at least 48 hours to transmit Lyme disease.
- Do a daily tick check to reduce your risk!
- The longer a tick is attached, the greater the risk of developing Lyme disease.
- **DO A THOROUGH DAILY TICK CHECK TO REDUCE YOUR RISK OF DEVELOPING LYME DISEASE.**

Remember it's not the tick you remove that is likely to give you Lyme disease, it's the one you never find.

Babesiosis

Babesiosis is an intraerythrocytic parasitic infection caused by protozoa of the genus *Babesia* and transmitted through the bite of the *Ixodes* tick. The disease most severely affects patients who are elderly, immunocompromised, or have undergone splenectomy. Babesiosis is usually an asymptomatic infection in healthy individuals.

The parasite only infects red blood cells (RBCs). This significantly affects the hematological system, causing hemolytic anemia, thrombocytopenia, and atypical lymphocyte formation.

Alterations in RBC membranes cause decreased conformability and increased red cell adherence, which can lead to development of acute respiratory distress syndrome (ARDS) among those severely affected.

- In the US: Babesiosis is limited to those who live in, or have recently traveled to, the northeastern United States. Few cases have been reported in California, Washington, Wisconsin, and Georgia. Hundreds of cases have been reported since the first domestic case of human Babesiosis was reported in 1966. An increasing trend over the past 30 years may be the result of restocking of the deer population, curtailment of hunting, and an increase in outdoor recreational activities. Although the most life-threatening cases occur in patients who are elderly, immunocompromised, or have undergone splenectomy, most patients with Babesiosis are asymptomatic, which may result in underreporting of the disease across all age groups.
- Internationally: Babesiosis in Europe, caused by a different species of *Babesia,* is a more devastating disease. Although rare, it is symptomatic and often fatal. Like its US counterpart, Babesiosis in Europe is also seen in patients who have undergone splenectomy.

Mortality/Morbidity:
The US mortality rate is low.

- Most cases are asymptomatic and improve spontaneously without treatment.
- Approximately 25% of patients with Babesiosis are co-infected with Lyme disease. These patients experience more severe symptoms for a longer duration than those with either disease alone.

In Europe, Babesiosis is a life-threatening disease.

- Of patients with Babesiosis, 84% are asplenic, and 53% become comatose and die.
- Of those rare reported cases of subclinical infection, all patients were infected by the same *Babesia* species that affects patients in the northeastern United States.

Sex: The male-to-female ratio is about 1:1.

Age: Babesiosis affects all age groups with similar frequency; however, patients older than 50 years are at increased risk for severe infection and death.

- No difference in seropositivity exists among age groups.
- Adequate reporting is a major problem, especially in children, because of masking by other infections and the disease's history of occurrence in elderly patients.

Tularemia

Tularemia is a bacterial disease associated with both animals and man. Although many wild and domestic animals have been infected, the rabbit is most often involved in disease outbreaks. Tularemia in humans is relatively rare.

Who gets tularemia?
Hunters or other people who spend a great deal of time outdoors are at a greater risk of exposure to tularemia than people with other occupational or recreational interests. Other groups at increased risk include veterinarians and those working with birds of prey (by handling rabbits as food for the bird).

How is tularemia spread?
Many routes of human exposure to tularemia are known to exist. The common routes include inoculation of the skin or mucous membranes with blood or tissue while handling infected animals bites from infected deer flies or ticks, or handling or eating insufficiently cooked rabbit meat. Less common means of spread are drinking contaminated water, inhaling dust from contaminated soil, or handling contaminated pelts or paws of animals.

What are the symptoms of tularemia?
The symptoms of tularemia are varied and depend upon where the organism enters the body. When it enters through the skin, tularemia can be recognized by the presence of a lesion and swollen glands. Ingestion of the organism may produce a throat infection, intestinal pain, diarrhea and vomiting. Inhalation of the organism may produce a fever alone or fever combined with a pneumonia-like illness.

How soon do symptoms appear?
Symptoms generally appear between two and 10 days, but usually after three days.

What is the treatment for tularemia?
Certain antibiotics such as streptomycin are effective in treating tularemia. Others such as gentamycin and tobramycin have also been reported to be effective.

Does past infection with tularemia make a person immune?
Long-term immunity will follow recovery from tularemia, but re-infection has been reported.

What can be done to prevent the spread of tularemia?
Rubber gloves should be worn when skinning or handling animals, especially rabbits. Wild rabbit and rodent meat should be cooked thoroughly before eating. Avoid bites of deer flies and ticks and avoid drinking untreated water.

Ehrlichiosis

Ehrlichiosis is caused by several bacterial species in the genus *Ehrlichia* (pronounced err-lick-ee-uh) which have been recognized since 1935. Over several decades, veterinary pathogens that caused disease in dogs, cattle, sheep, goats, and horses were identified. Currently, three species of *Ehrlichia* in the United States and one in Japan are known to cause disease in humans; others could be recognized in the future as methods of detection improve.

In 1953, the first ehrlichial pathogen of humans was identified in Japan. Sennetsu fever, caused by *Ehrlichia sennetsu*, is characterized by fever and swollen lymph nodes. The disease is very rare outside the Far East and Southeast Asia, and most cases have been reported from western Japan.

In the United States, human diseases caused by *Ehrlichia* species have been recognized since the mid-1980s. The ehrlichioses represent a group of clinically similar, yet epidemiologically and etiologically distinct, diseases caused by *Ehrlichia chaffeensis*, *E. ewingii,* and a bacterium extremely similar or identical to *E. phagocytophila*. The remainder of the information on this page will focus on the types of ehrlichiosis that occur in the United States.

Human ehrlichiosis due to *Ehrlichia chaffeensis* was first described in 1987. The disease occurs primarily in the southeastern and south central regions of the country and is primarily transmitted by the lone star tick, *Amblyomma americanum*.

Human granulocytic ehrlichiosis (**HGE**) represents the second recognized ehrlichial infection of humans in the United States, and was first described in 1994. The name for the species that causes HGE has not been formally proposed, but this species is closely related or identical to the veterinary pathogens *Ehrlichia equi* and *Ehrlichia phagocytophila*.

HGE is transmitted by the blacklegged tick (*Ixodes scapularis*) and the western blacklegged tick (*Ixodes pacificus*) in the United States.

Ehrlichia ewingii is the most recently recognized human pathogen. Disease caused by *E. ewingii* has been limited to a few patients in Missouri, Oklahoma, and Tennessee, most of whom have had underlying immunosuppression. The full extent of the geographic range of this species, its vectors, and its role in human disease is currently under investigation.

Colorado Tick Fever

What is Colorado Tick Fever?
Colorado Tick Fever is an illness caused by a virus carried by small mammals, such as ground squirrels, porcupines, chipmunks, and by ticks.

Who gets Colorado Tick Fever?
Anyone can get Colorado Tick Fever who lives or travels in areas of the western United States and Canada at elevations above 5000 feet and who comes in contact with infected ticks, especially *Dermacentor andersoni*, also known as the wood tick.

How is Colorado Tick Fever spread?
People get Colorado Tick Fever from a tick bite. There is no evidence of natural person-to-person transmission. However, rare cases of transmission from blood transfusions have been reported. The virus which causes Colorado Tick Fever may stay in the blood for as long as 4 months after onset of the illness.

What are the symptoms of Colorado Tick Fever?
The disease causes fever of about 103°F., chills, nausea, and severe headache. These symptoms usually last a few days, go away, and then return for a few days. Sometimes the symptoms include a red, raised rash.

How soon do symptoms usually appear?
The symptoms generally begin 4 to 5 days after being bitten by an infected tick.

How should a tick be removed?
Ticks should be removed promptly and carefully by using tweezers and applying gentle steady traction. Do not crush the tick's body when removing it and apply the tweezers as close to the skin as possible to avoid leaving tick mouth parts in the skin. Do not remove ticks with your bare hands. Protect your hands with gloves, cloth or tissue and be sure to wash your hands after removing a tick.

How can Colorado Tick Fever be prevented?
1. Avoid tick infested areas, especially during the warmer months.
2. Wear light colored clothing so ticks can be easily seen. Wear a long sleeved shirt, hat, long pants, and tuck your pant legs into your socks.
3. Walk in the center of trails to avoid overhanging grass and brush.
4. Check your body every few hours for ticks when you spend a lot of time outdoors in tick infested areas. Ticks are most often found on the thigh, arms, underarms and legs. Ticks can be very small (no bigger than a pinhead). Look carefully for new "freckles".
5. Use insect repellents containing DEET on your skin or permethrin on clothing. Be sure to follow the directions on the container and wash off repellents when going indoors.
6. Remove attached ticks immediately.

Q Fever

Q fever is a zoonotic disease caused by *Coxiella burnetii,* a species of bacteria that is distributed globally. In 1999, Q fever became a notifiable disease in the United States but reporting is not required in many other countries. Because the disease is underreported, scientists cannot reliably assess how many cases of Q fever have actually occurred worldwide. Many human infections are unapparent.

Cattle, sheep, and goats are the primary reservoirs of *C. burnetii*. Infection has been noted in a wide variety of other animals, including other breeds of livestock and in domesticated pets. *Coxiella burnetii* does not usually cause clinical disease in these animals, although abortion in goats and sheep has been linked to *C. burnetii* infection.

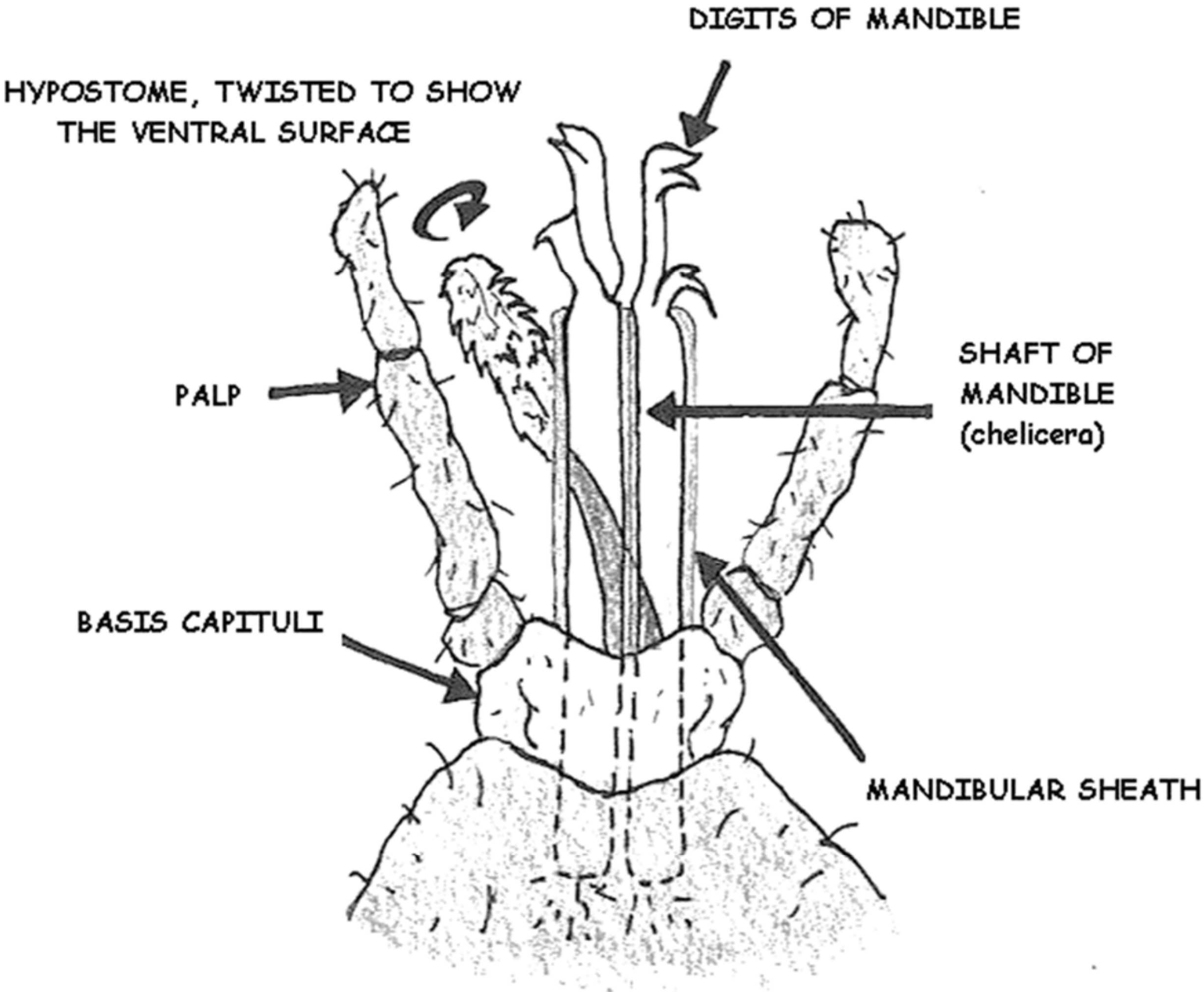
Organisms are excreted in milk, urine, and feces of infected animals. Most importantly, during birthing the organisms are shed in high numbers within the amniotic fluids and the placenta. The organisms are resistant to heat, drying, and many common disinfectants. These features enable the bacteria to survive for long periods in the environment. Infection of humans usually occurs by inhalation of these organisms from air that contains airborne barnyard dust contaminated by dried placental material, birth fluids, and excreta of infected herd animals. Humans are often very susceptible to the disease, and very few organisms may be required to cause infection.

Ingestion of contaminated milk, followed by regurgitation and inspiration of the contaminated food, is a less common mode of transmission. Other modes of transmission to humans, including tick bites and human to human transmission are rare.

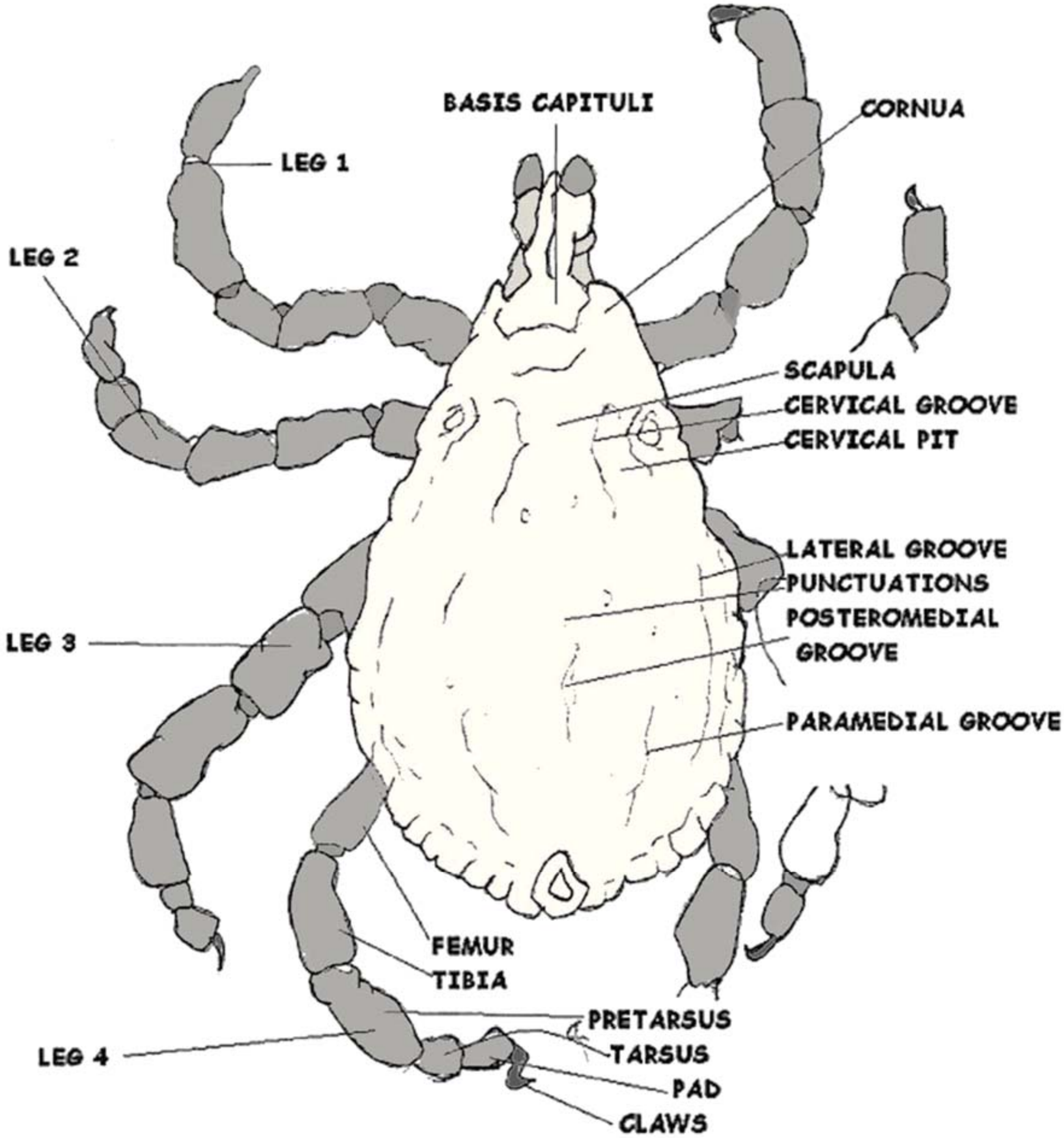
Signs and Symptoms in Humans
Only about one-half of all people infected with *C. burnetii* show signs of clinical illness. Most acute cases of Q fever begin with sudden onset of one or more of the following: high fevers (up to 104-105° F), severe headache, general malaise, myalgia, confusion, sore throat, chills, sweats, non-productive cough, nausea, vomiting, diarrhea, abdominal pain, and chest pain. Fever usually lasts for 1 to 2 weeks. Weight loss can occur and persist for some time. Thirty to fifty percent of patients with a symptomatic infection will develop pneumonia. Additionally, a majority of patients have abnormal results on liver function tests and some will develop hepatitis.

Chronic Q fever, characterized by infection that persists for more than 6 months, is uncommon but is a much more serious disease. Patients who have had acute Q fever may develop the chronic form as soon as 1 year or as long as 20 years after initial infection. A serious complication of chronic Q fever is endocarditis, generally involving the aortic heart valves, less commonly the mitral valve. Most patients who develop chronic Q fever have pre-existing valvular heart disease or have a history of vascular graft. Transplant recipients, patients with cancer, and those with chronic kidney disease are also at risk of developing chronic Q fever.

As many as 65% of persons with chronic Q fever may die of the disease. The incubation period for Q fever varies depending on the number of organisms that initially infect the patient. Those who recover fully from infection may possess lifelong immunity against re-infection. In general, most patients will recover to good health within several months without any treatment. Only 1%-2% of people with acute Q fever die of the disease.



ANATOMY OF A TICK


BASIS CAPITULI
CORNUA
LEG 1
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SCAPULA
CERVICAL GROOVE
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PUNCTUATIONS
POSTEROMEDIAL GROOVE
LEG 3
PARAMEDIAL GROOVE
FEMUR
TIBIA
PRETARSUS
LEG 4
TARSUS
PAD
CLAWS

Monitoring and Thresholds for Ticks

Periodic surveys of potential or known tick habitats can reveal the presence of low-level tick infestations. This permits the application of management procedures to prevent or retard further population increase. Monitoring techniques that have proven effective (Gladney 1978) are as follows:

Examination of personnel for attached ticks. A volunteer wearing protective clothing walks through each sample site and is then inspected. Ticks attached to or walking on the collector's clothing and skin are collected in 70% ethanol for later identification and counting. Careful inspection is necessary to prevent the attachment of unnoticed ticks and possible disease transmission to the collector. Collections can be standardized in relation to time, distance, or area units covered during sampling.

Dragging/flagging. Done by dragging a white cloth over relatively open ground or "*flagging*" low-level vegetation (i.e., moving the cloth in a waving motion over and through vegetation) in densely brushy ground. Ticks that are questing for passing hosts cling to the cloth and can be removed for identification and counting. The "*drag*" consists of a 1 yd^2 piece of white crib bedding or corduroy material hemmed on all edges, weighted at one end, and attached to a wooden pole at the opposite end. A rope attached to the two ends of the pole allows the device to be dragged along the ground. Alternatively, the pole can be gripped at one end so that the cloth hangs vertically downwards, and the device used to flag vegetation. Dragging or flagging success depends upon the degree of contact between the cloth and ground or vegetation surface.

Useful drag techniques are described by Gladney (1978). The selection of sampling sites may have significant effects on the success of the sampling effort. Sampling sites should reflect favored tick habitats for best success. Sampling should be done under conditions that favor tick presence and activity (e.g., when vegetation is not wet and when ambient temperature is above 50˚F).

Dry-ice traps. This has been proven to be the most efficient method of tick collection. It is non-destructive to host animals, does not require a human as an "*attractant*", and gives more reproducible results than dragging. However, the traps need to be kept in the field for several hours (preferably overnight) for best results. Dry ice is available at ice cream and beverage stores. The basic principle is to use carbon dioxide vaporizing from the dry ice to attract ticks onto a white cloth panel on which they are easily visible and can be removed periodically (if the traps are set out for a limited time under periodic monitoring), or onto a platform lined with double- sided sticky tape on which they get trapped (if the traps are set out overnight). Information on trap designs can be obtained from Garcia (1965), Gladney (1978), and Mount and Dunn (1983).

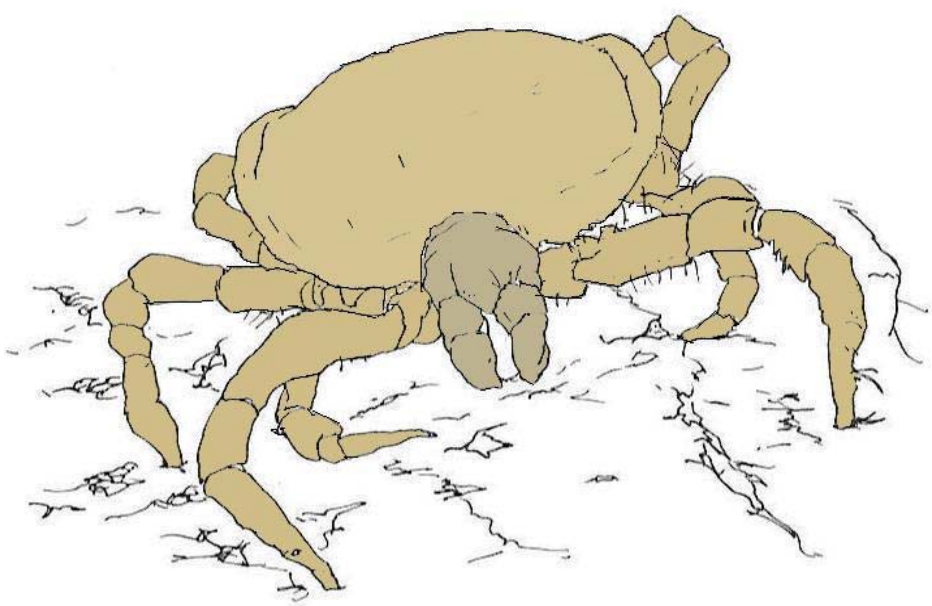
Trapping small animal hosts. Small mammals such as rodents and insectivores can be live-trapped at selected sampling sites, with traps set out in grids or line transects. Trapped animals are anesthetized and searched thoroughly for attached ticks, which are removed using fine forceps. Removed ticks can be stored in 70% ethanol pending identification and counting. The animal host is released at the site of capture after recovery from anesthesia. Gloves should be worn throughout all animal and tick handling operations. A veterinarian or qualified technician should be consulted on the proper usage of anesthetics administered to trapped animals. Sampling sites for monitoring ticks should be selected in areas favoring ticks or are likely to receive heavy human visitation. A conscientious monitoring program is the basis of effective integrated pest management.

Regular surveys should be done at all sites where ticks have been reported by staff or visitors and at other locations that appear to be favorable tick habitats. Complete and accurate records of sampling sites and methods must be kept so that the progress of tick populations and the effect of control measures can be gauged. After collecting the ticks, store them in rubbing alcohol or freeze in a plastic container to preserve them.

Threshold for Ticks

Mount (1981) proposed an arbitrary tolerance threshold of one tick/dry-ice sample, based on several years of study in recreational areas in Oklahoma. Mount and Dunn (1983) recommended that a count of 0.65 ticks per one hour of CO_2 exposure (dry-ice traps) be considered the economic threshold in lone star tick management (equivalent to one tick per visitor per day, based on the assumption that most human visitors to recreational areas will not spend more than one hour per day in tick habitats).

This value may not be applicable to your particular situation and a suitable threshold level can be established by conducting regular CO_2 surveys and plotting tick counts against the numbers of tick bite complaints received. This will permit the selection of a complaint threshold level for each site surveyed. Treatment should be conducted to keep tick populations below the selected threshold; a lower "action" level should be selected to trigger treatment programs. The same technique is applicable to other species of ticks as well.



TICK

Tick Control 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.

Brown Dog Tick

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.

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.**		

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.**		

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.

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.

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.

Florida Cooperative Extension Service / Institute of Food and Agricultural Sciences / University of Florida / Christine Taylor Waddill, Dean

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.

Non-Chemical Control of Ticks

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.

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.

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.

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 Summary

When feeding, ticks make a small hole in the skin, attach themselves with a modification of one of the mouthparts which has teeth that curve backwards, and insert barbed piercing mouthparts to remove blood.

The presence of ticks is annoying to dogs and humans. Heavy continuous infestations on dogs cause irritation and loss of vitality. Pulling ticks off the host may leave a running wound which may become infected because of their type of attachment.

The brown dog tick is not a vector of human disease, but it is capable of transmitting canine piroplasmosis among dogs.

The American dog tick may carry Rocky Mountain spotted fever, tularemia, and other diseases from animals to people. Dogs are not affected by these diseases, but people have become infected by picking ticks from dogs. People living in areas where these wood ticks occur should inspect themselves several times a day. Early removal is important since disease organisms are not transferred until the tick has fed for several hours.

The American dog tick is also known to cause paralysis in dogs and children where ticks attach at the base of the skull or along the spinal column. Paralysis is caused by a toxic secretion produced by the feeding tick. When the tick is removed, recovery is rapid, usually within 8 hours. Sensitized animals may become paralyzed by tick attachment anywhere on the body. Deer ticks - also referred to as 'black-legged' ticks - are the only ticks that transmit Lyme disease.

Lyme disease is caused by the organism called Borrelia burgdorferi.

Immature ticks called 'nymphs' pick up the organism from infected rodents (i.e., mice, chipmunks and others). Deer play an important role in maintaining the tick population.

Deer ticks are generally found in humid environments such as leaf litter, overgrown vegetation and wooded areas.

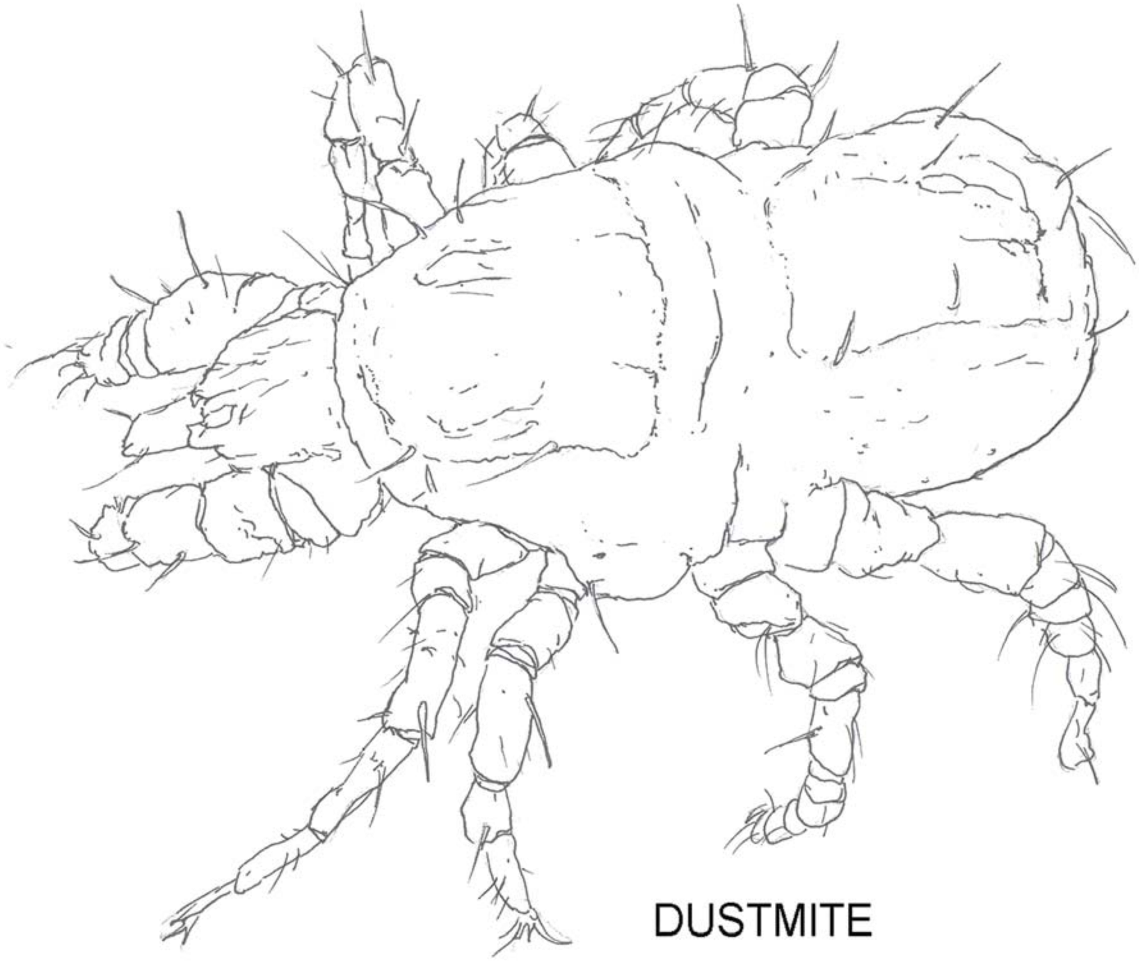
Deer ticks don't jump, fly or drop from trees; you must brush against or otherwise come in direct contact with them.

Not all ticks are infected - about 20% of nymphal ticks and 40% of adults are carriers.

In most cases, 48 hours of attachment to humans is needed before a tick can transmit the organism that causes Lyme disease.

Frequent tick checks are an essential piece of Lyme prevention; In fact, if an attached tick is found and removed, the chances of developing Lyme disease are just 1 - 3%.

Nymphs - which cause most Lyme disease cases— are most active in late spring and early summer; however, adult ticks are active from October through April, whenever temperatures rise above 100°F.



DUSTMITE

Tick Section Post Quiz

1. 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______________, a central piercing element with hooks, into the host's skin.

2. Some ticks secrete a ___________to fasten them-selves to the host. In addition, *Ixodes* ticks secrete anticoagulant, immunosuppressive, and anti-inflammatory substances into the area of the tick bite.

3. These substances presumably help the tick to obtain a blood meal without the host's noticing. These same substances also help any ____________to establish a foothold in the host.

4. The American dog tick is found throughout the United States except in parts of the ______________region. It also occurs in parts of Canada and Mexico.

5. Its habitat includes wooded areas, abandoned fields, medium height grasses and shrubs between wetlands and woods, and sunny or open areas around__________.

6. ____________feed primarily on small mammals (especially rodents); while the adults feed mainly on dogs, but will readily bite humans.

7. The female lays _____________ellipsoidal eggs over a 14-32 day period and then dies. The eggs usually hatch in 36-57 days.

8. _____________ usually engorge for 3-5 days, nymphs for 3-11 days, and adult females for 5-13 days.

9. Unfed larvae can live up to ___________ months, nymphs 20 months and adults 30 months or longer.

10. Pyrethrum is a natural insecticide extracted from certain_______________.

Answers

1. Hypostome, 2. Cementing material, 3. Freeloading pathogens, 4. Rocky Mountain, 5. Woods, 6. Larvae and nymphs, 7. 4,000-6,500, 8. Larvae, 9. 15, 10. Chrysanthemum plants

Spider Section

Myth: "***Arachnid***" is just a fancy name for spider.
Fact: 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 are 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

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. Most of its marine representatives are extinct, but were prominent in the Paleozoic Era and included some fearsome predators.

There is a theory that the first ancestral chelicerates probably evolved about 600 million years ago. 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.

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 creatures 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 dependant on the fact that large numbers of eggs are produced at a time, and it is likely that at least a few will survive.

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).

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.

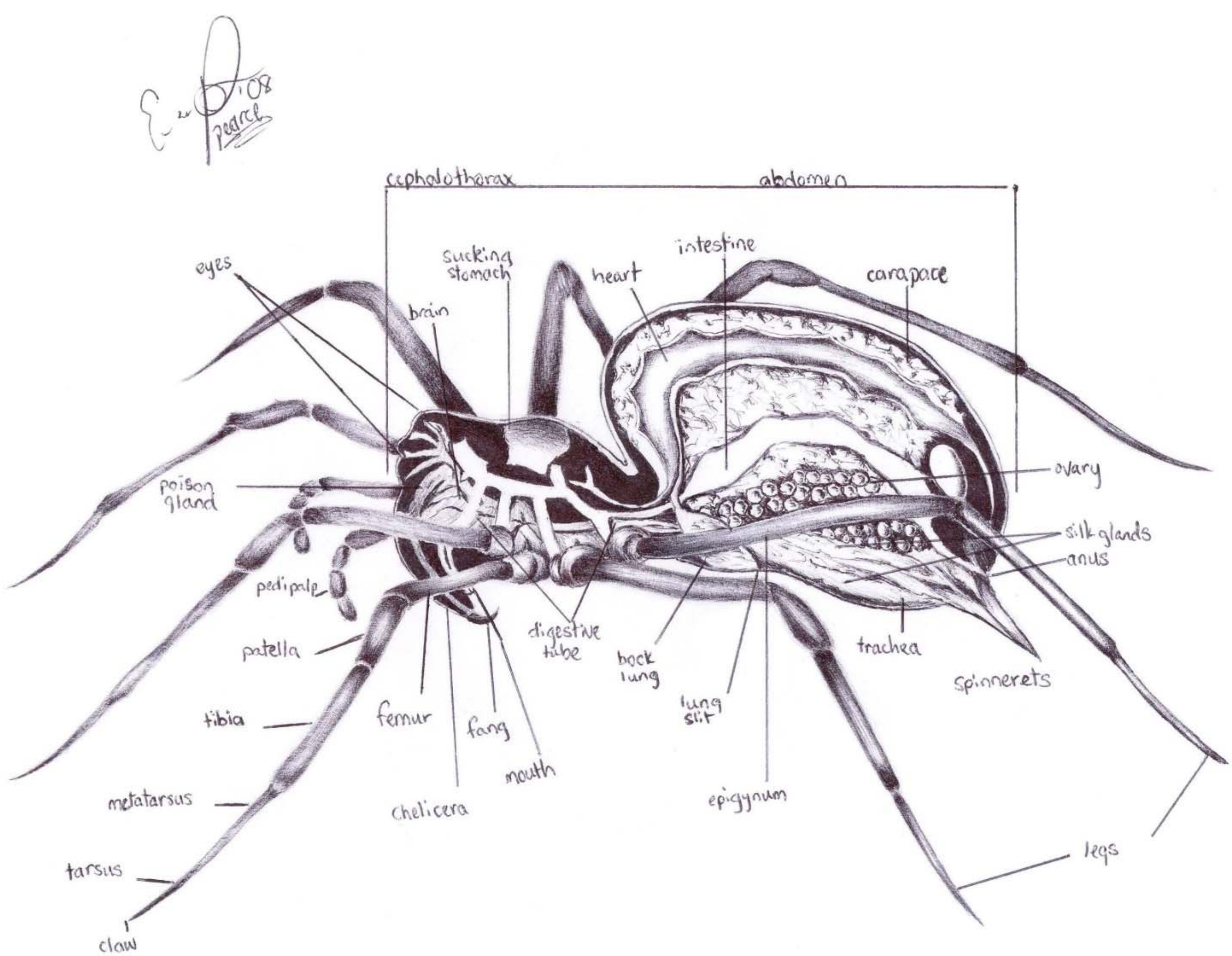
The spider’s bite can kill children and the elderly, but among strong young farmers it leads to erections that can last for days and involve involuntary ejaculations. At the end of the ordeal, the man is left sexually energized and feels physically stronger, the saying goes.

Short and sweet comment, if your wife places spiders in your lunch box, she is trying to tell you something.

Spider Introduction

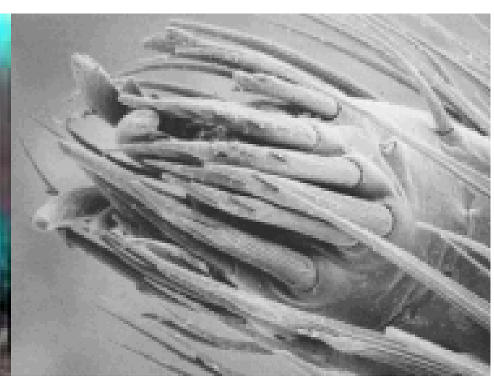
Spiders are mostly terrestrial, of the class Arachnida, order Araneae, with four pairs of legs and a two-part body consisting of a cephalothorax, or prosoma, and an unsegmented abdomen, or opisthosoma. The cephalothorax is covered by a shield, or carapace, and bears eight simple eyes. On the underside 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.



General Spider Anatomy

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. Pedicel (waist).
4. Distinctive red hourglass mark.
5. Spinnerets (silk glands).
6. Abdomen. Contains guts, reproductive organs, heart and silk glands.

Close-up photographs of the Black Widow's eyes and claw.

Spiders

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, leglike 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.

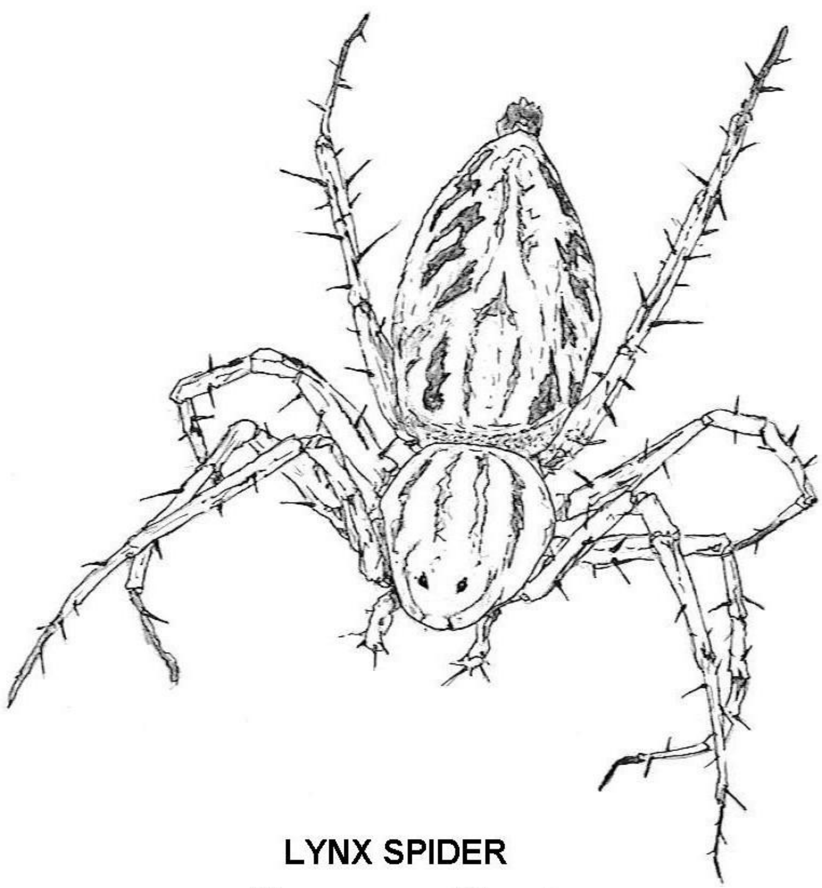
Each leg is made up of seven jointed segments, called the coxa, trochanter, femur, patella, tibia, metatarsus, and tarsus. More than 30 muscles control the movement of each leg. In addition, some joints of the leg move by the hydraulic action of body fluid.

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).

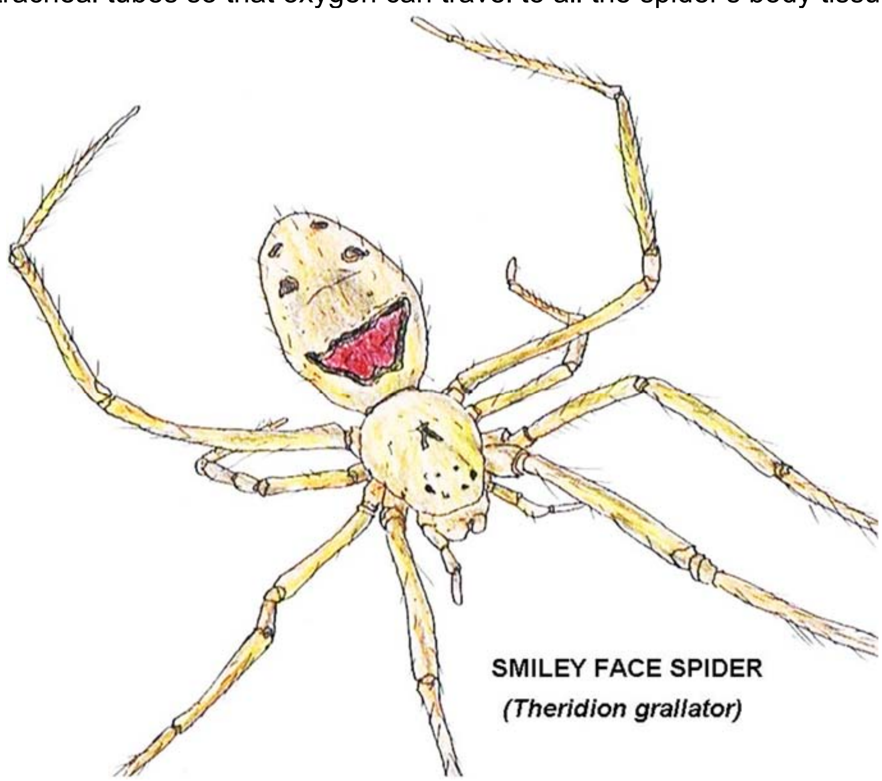


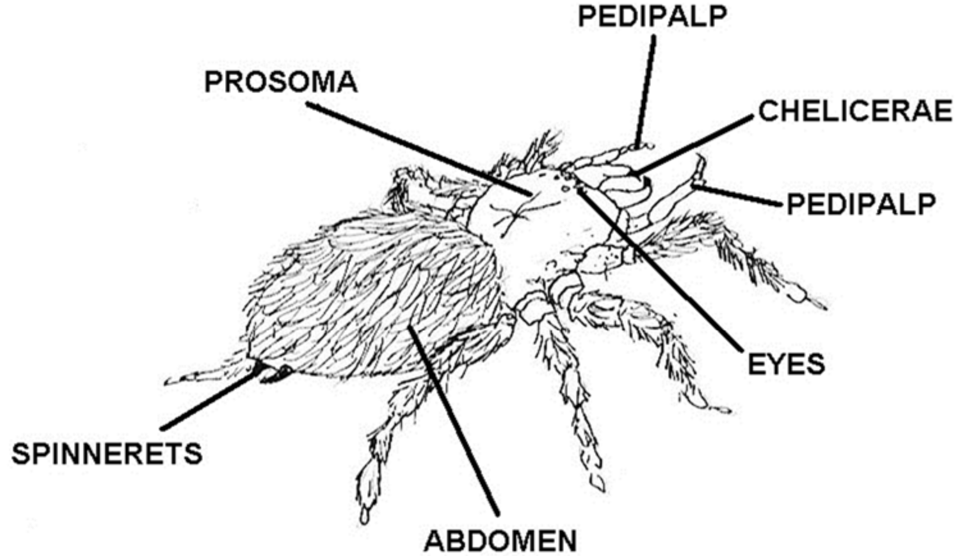
LYNX SPIDER
(Oxyopes salticus)

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, hairlike 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.

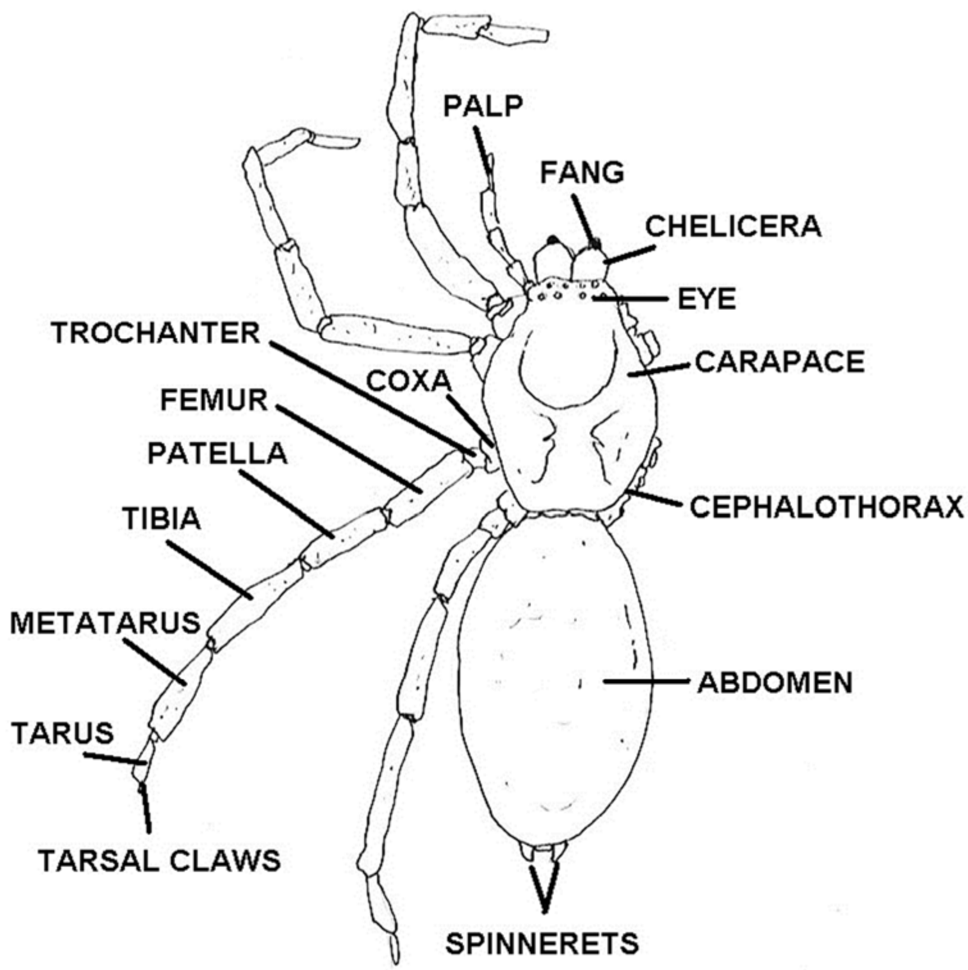
Internal Anatomy and Function
The cephalothorax houses part of the digestive system and the central nervous system. The abdomen contains most of the spider's vital organs, including a long, tubular heart; respiratory organs; reproductive organs; and excretory organs.

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.


SMILEY FACE SPIDER
(Theridion grallator)



SPIDER PARTS



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.

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 Identification Section

Ground Spiders

Tarantula

True tarantulas are a type of wolf spider that belongs 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.

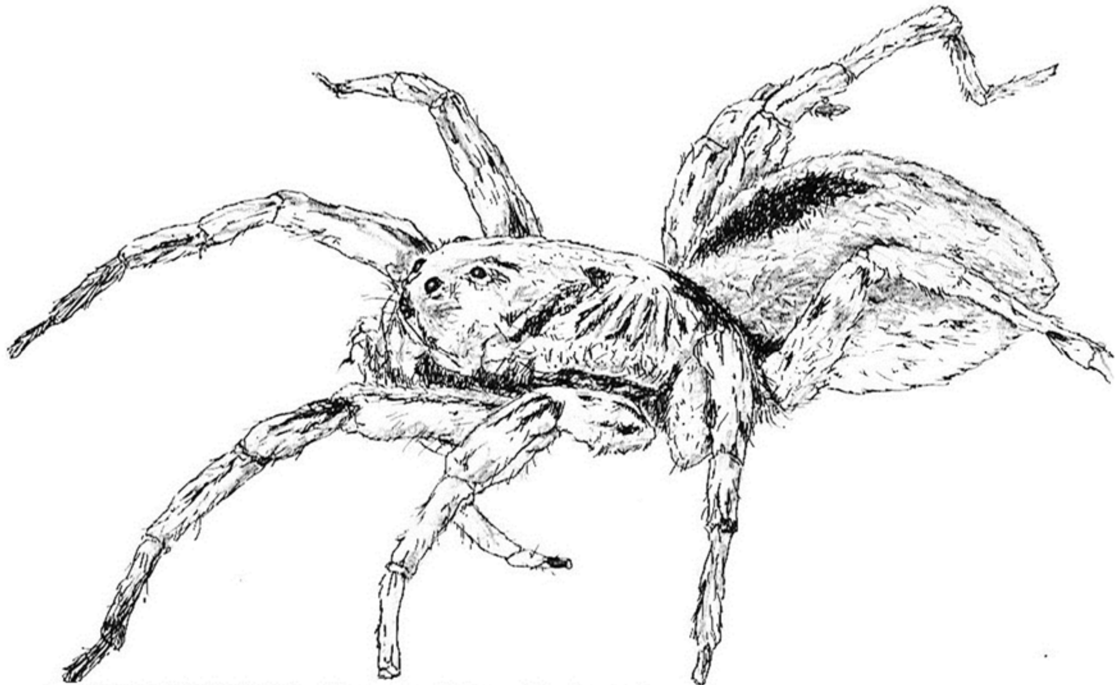
Tarantulas are popular pets, and some become so tame that they can be picked up and handled safely. Although the chance of receiving a bite is small, there is another danger: Many tarantulas brush off their abdominal hairs when they feel threatened. These barbed hairs fly through the air and can penetrate 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. 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 ***(Lycosidae 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 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.

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."[2] 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 "caterpillarlike", whereas those of Apocrita are largely predatory or "parasitic" (technically known as parasitoid).

Jumping Spider

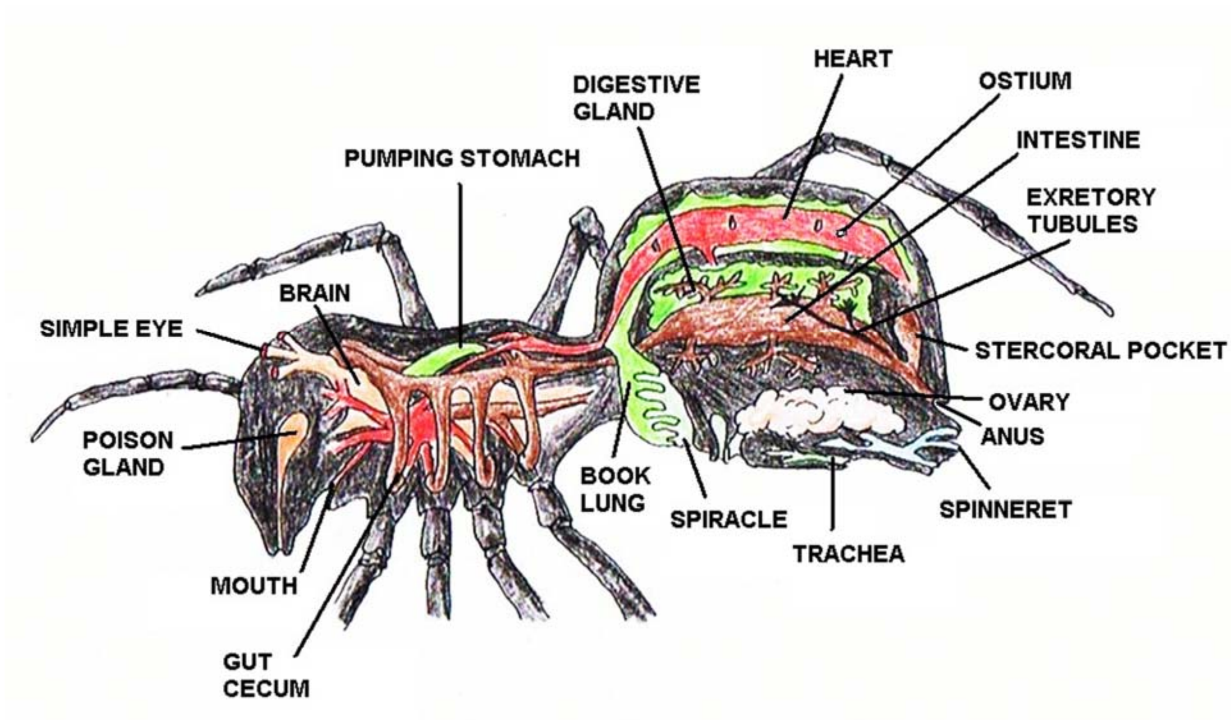
The jumping spiders are active hunters. Depending on the species, they can leap up to 25 times their body length when stalking prey. They belong to the family Salticidae, the largest spider family, with more than 4,000 species, in the suborder Araneomorphae. Jumping spiders are found mostly in tropical 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.

Common name: Jumping spider; Genus/species: Metaphidippus sp.; Order/family: Araneae: Salticidae; Stage: Adult. *Pretty cool little insect.*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BRAIN
SIMPLE EYE
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OVARY
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BOOK LUNG
SPIRACLE
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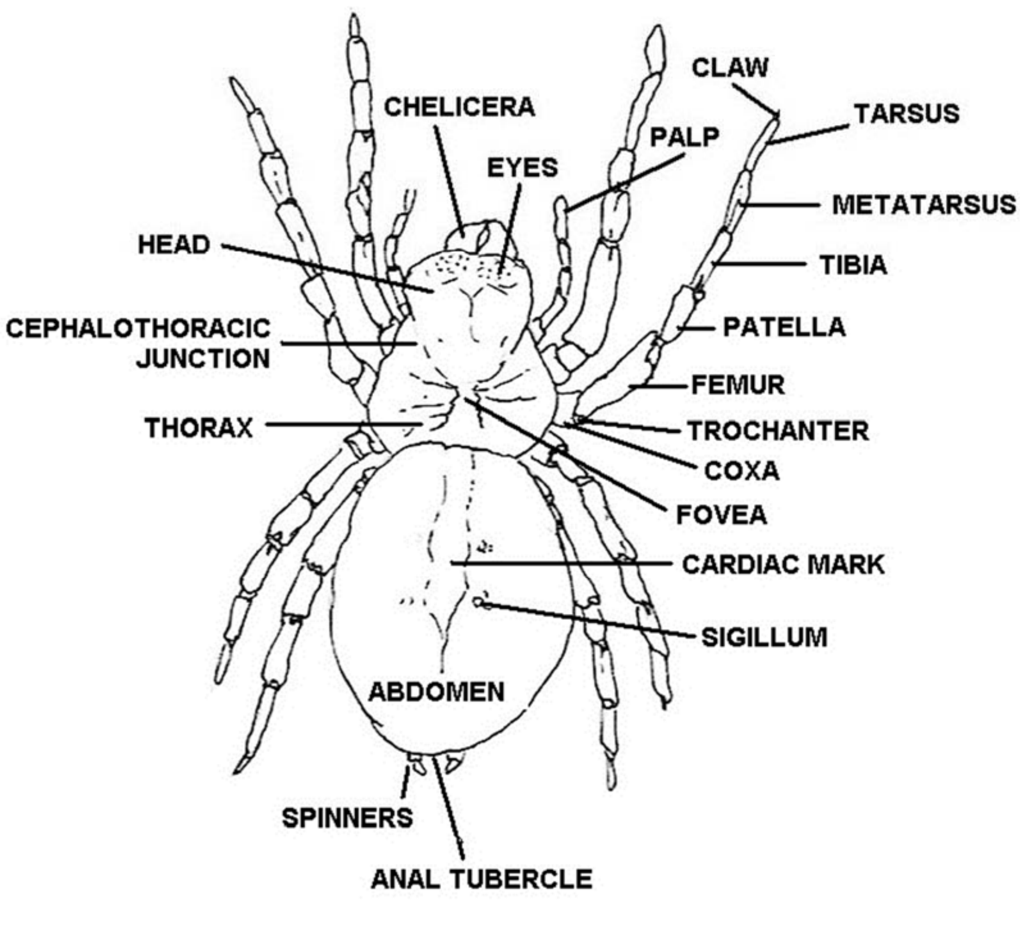
CLAW
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THORAX
TROCHANTER
COXA
FOVEA
CARDIAC MARK
SIGILLUM
ABDOMEN
SPINNERS
ANAL TUBERCLE

Web Spiders

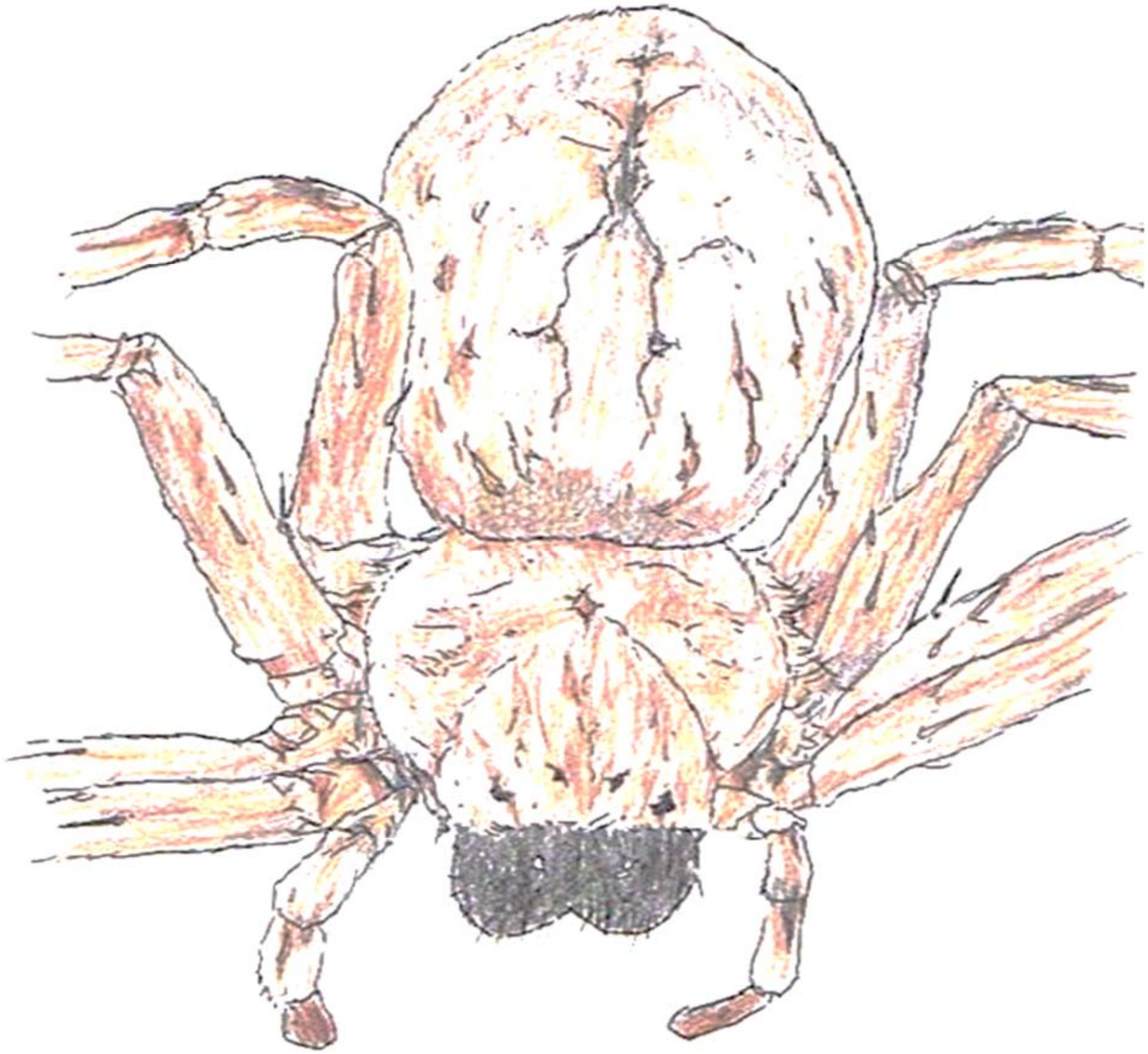
House Spider
The common house spider belongs to the funnelweb spiders in the family Agelenidae in the suborder Araneomorphae. House spiders are found throughout Europe and North America. This spider is so named because its horizontal sheet web is often seen in wall corners of houses, but it can also 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.

European House Spider

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.



GIANT CRAB SPIDER

(Olios giganteus)


Black Widow Brown Recluse

Black Widow Spider

Araneae: Theridiidae, 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.

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.

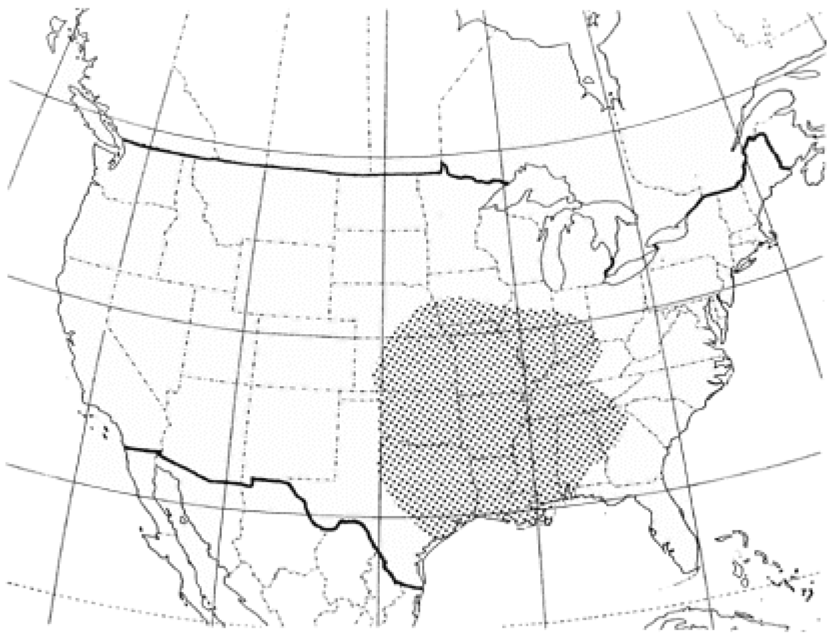
Be very careful when working around areas where black widow spiders may be established. Take proper precautions, wear gloves, and pay attention to where you are working. Black widow bites are sharp and painful, and the victim should go to the doctor immediately for treatment.

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.

American Recluse Spiders

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.

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.



Distribution of populations of the brown recluse, *Loxosceles reclusa,* in the United States. Areas around the borders of the shaded area may also have brown recluses, but they will be less common. Illustration by R. Vetter.

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.

Neil Young 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, that honor goes to Roy Orbison whose name graces the whirligig beetle (Orectochilus orbisonorum).

Brown Recluse Spider

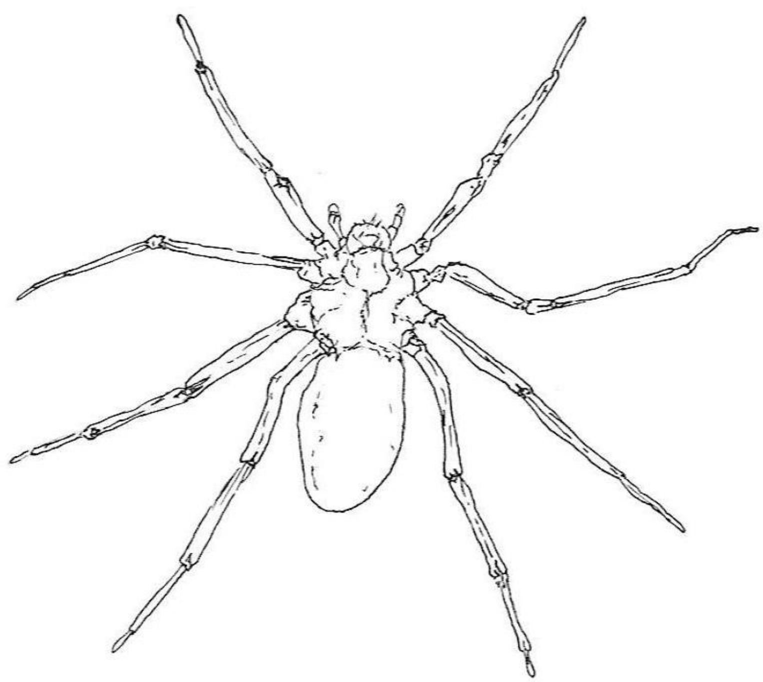
Araneae: Loxascelidae, Loxosceles reclusa

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).



BROWN RECLUSE ***(Loxascelidae Reclusa)***

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 nonrecluse 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 nonrecluse 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.

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.

Brown Recluse Spider Bite

This guy was bitten by a Brown Recluse spider.

It's summertime and cleanup is going on. Be careful where you put your hands. They like dark spaces and woodpiles, and cool areas in the attic.

Day 3, not too bad.

The following illustrates the progression of a brown recluse spider bite.
The affected skin actually dies on his body.

Day 5, it is getting worse. Pain is intense.
Some of the photographs towards the end are pretty nasty,
but take a look at the last one -- it is a photograph of the spider itself.

Day 6, time to worry. The smell of dead flesh and puss is horrible.

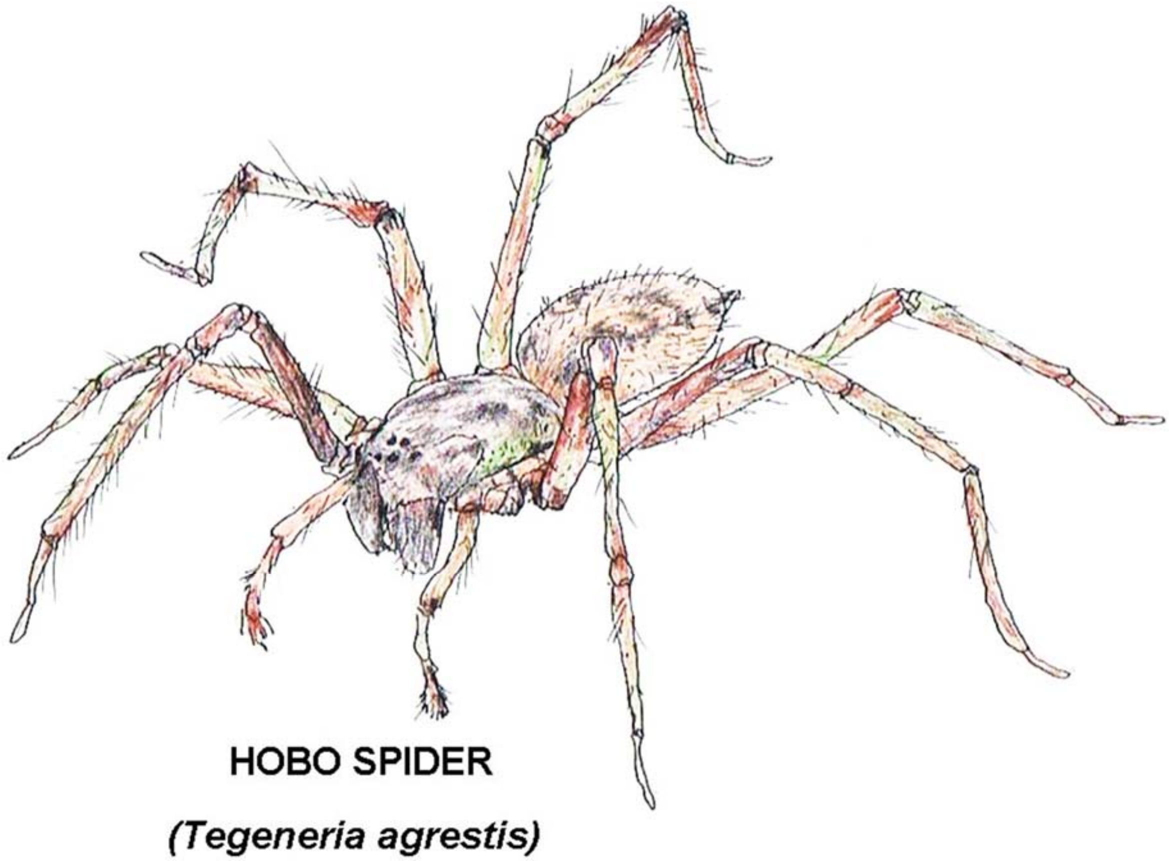
The Brown Recluse Spider is the most
dangerous spider that we have here in the USA.

Day 9, forget it, time to think about losing your arm. You are now in the hospital and on the news. This man barely lived; most people do not recover past this point. Be careful, I think that it would be strange to meet people in Heaven and find out that they got an one-way ticket because of a spider bite. A person can die from its bite. We all should know what the spider looks like. In fact, I get the creeps thinking about this dude.

Day 10, EWWW.

The dangerous and beatiful Brown Recluse Spider.

Hobo Spider Information



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.

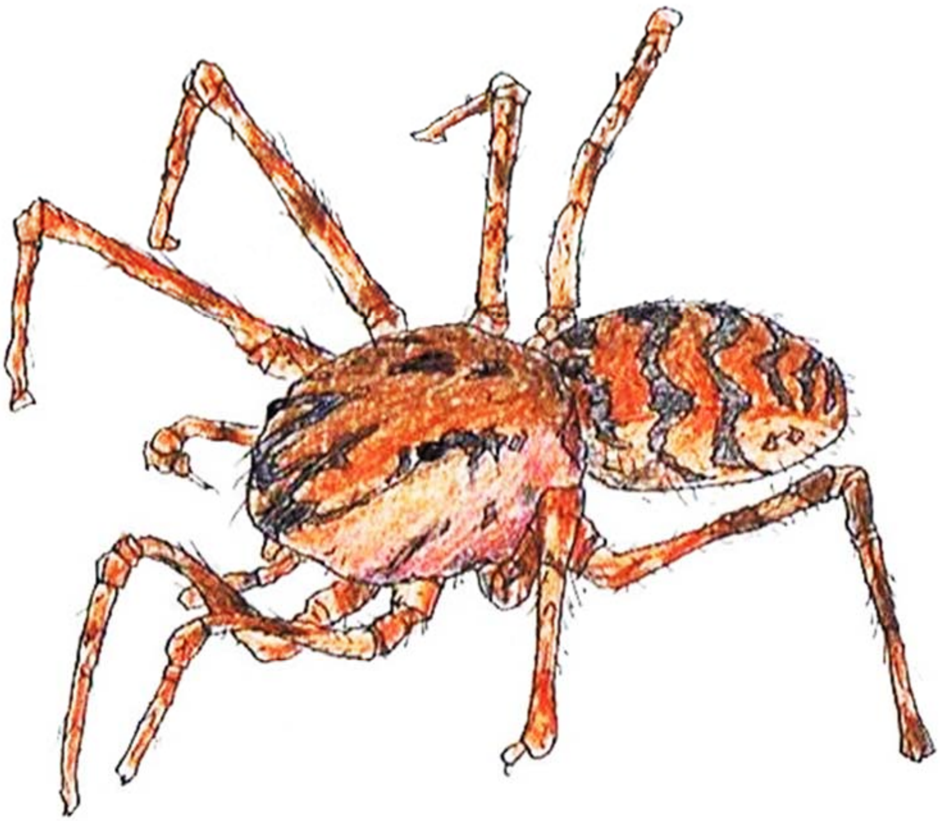
The hobo spider, originating from Europe, began its infestation of the continental USA in the Port of Seattle some time before the 1930's. Most poisonous spider bites in the western half of the USA are due to the Hobo spider. A venomous bite from a Hobo or Brown Recluse Spider can be severe. Necrotic 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.

Male Hobo Spider

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.

Six-Eyed Spiders

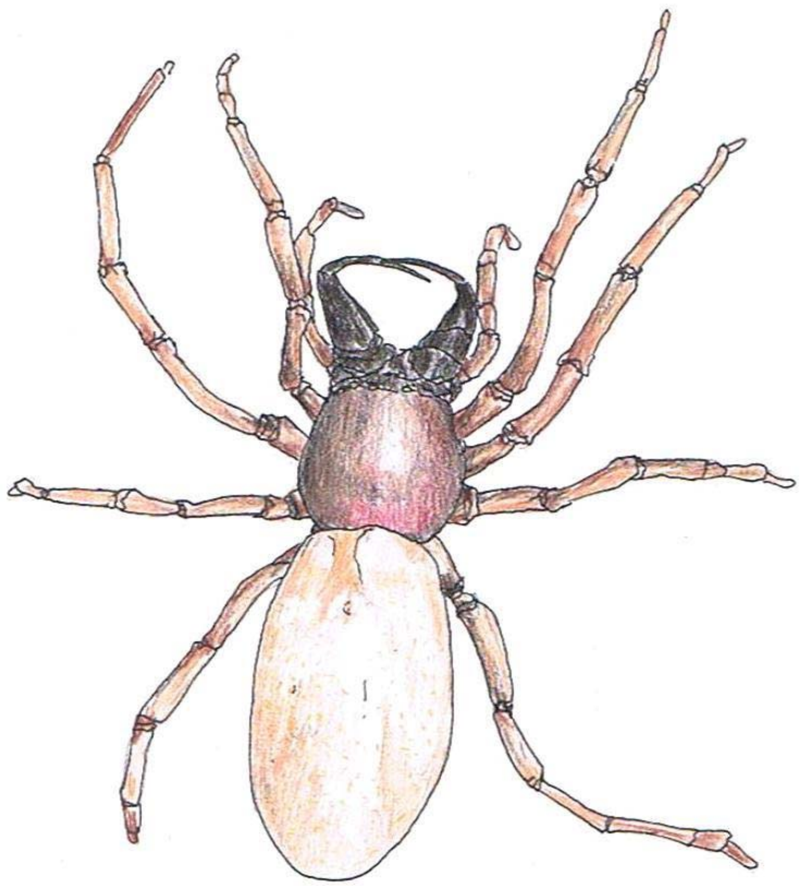


SPITTING SPIDER *(Scytodes thoracica)*

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

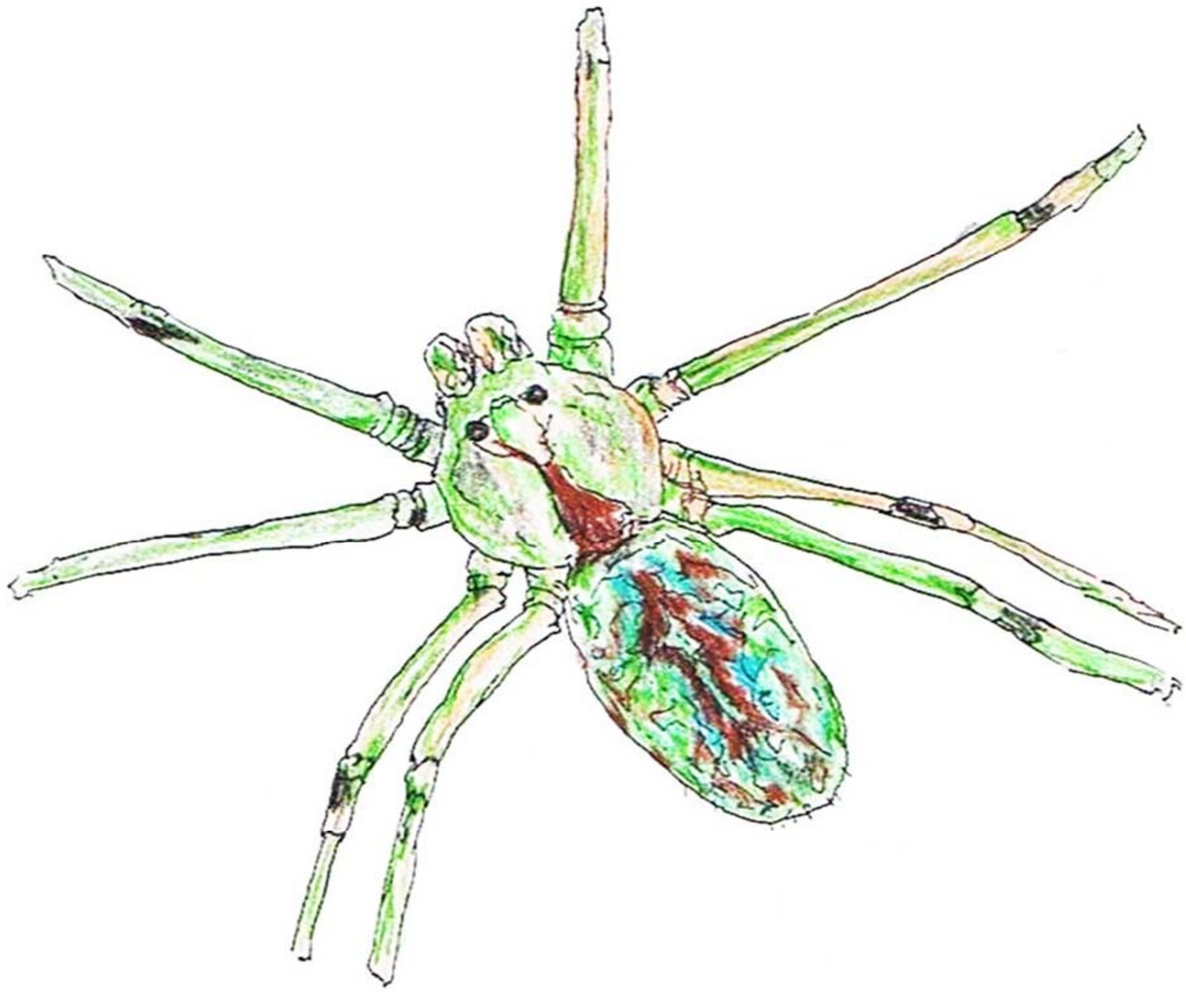
(Dysdera crocata)

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.

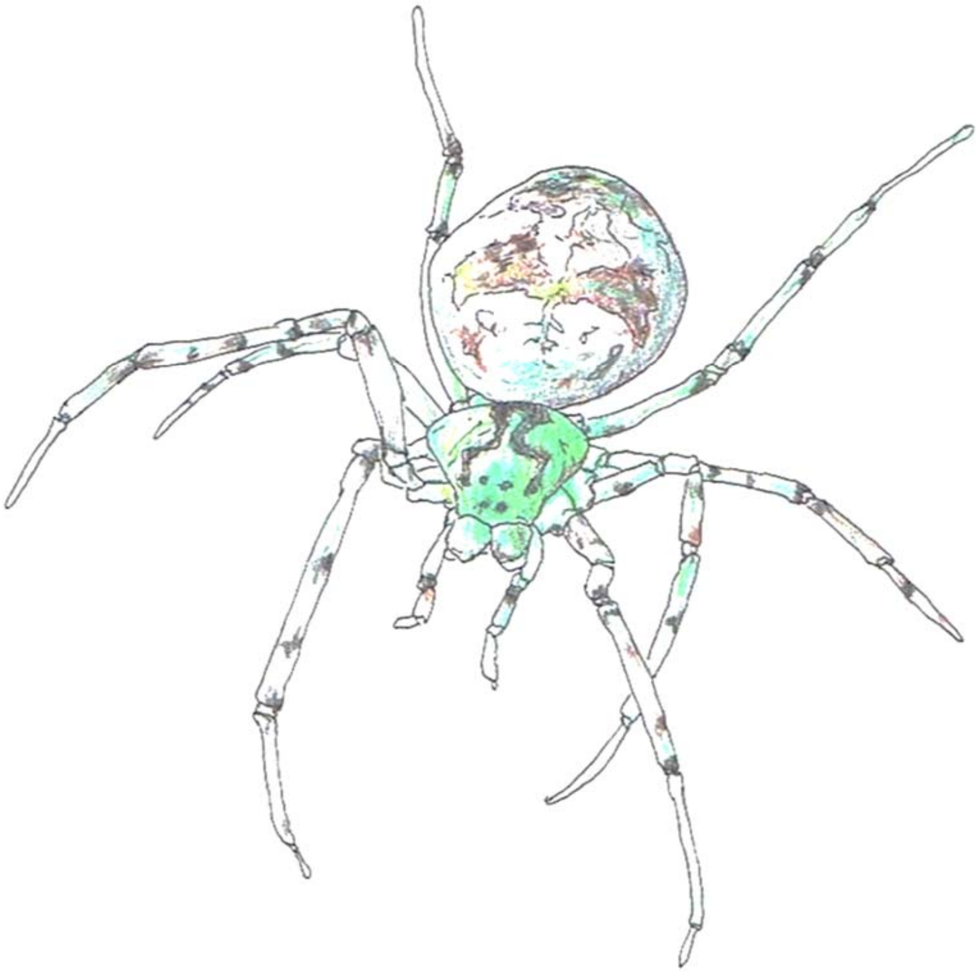
Seek medical attention if you think you have a spider bite. If possible, collect up the spider or what remains of it and take with you to your doctor or emergency clinic.

Orb weavers (Araneidae)

AMERICAN HOUSE SPIDER (TYPE OF 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.

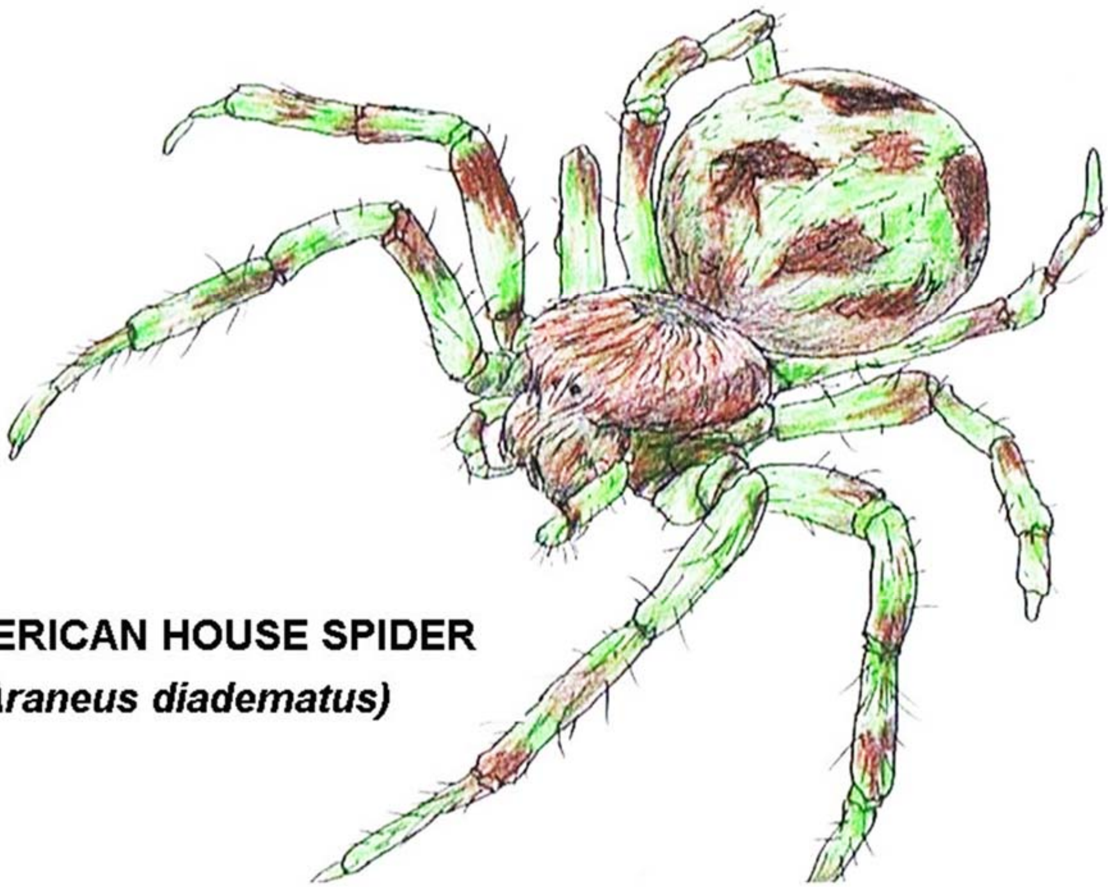
Garden spiders have been known to stridulate when threatened. Since this tends to be a passive animal, it is difficult to provoke to bite- but if it does, the bite is just slightly unpleasant and completely harmless to humans.



TYPE OF ORBWEAVER (UNKNOWN COMMON NAME)
(Metellina segmentata)

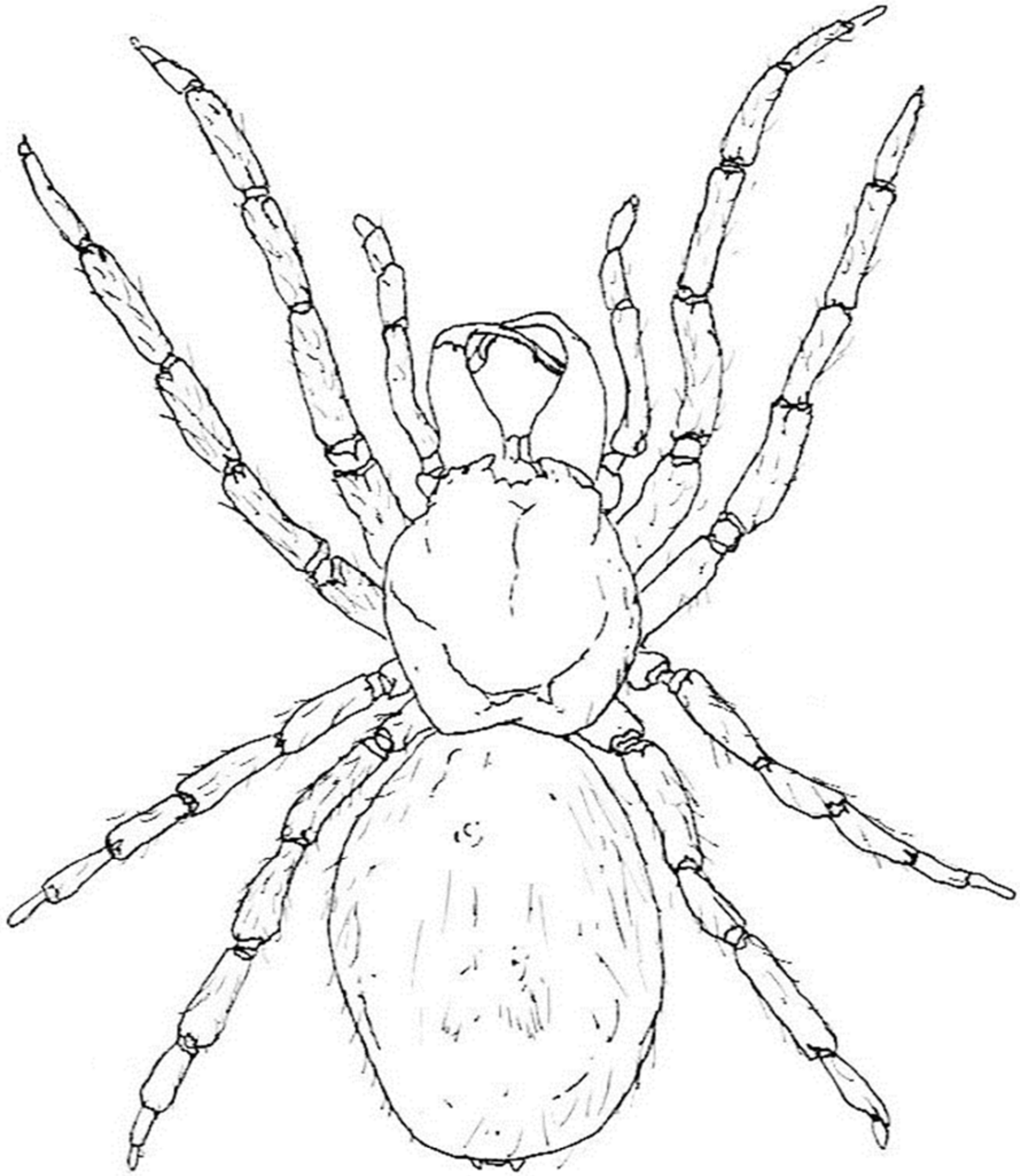
Metellina (or Meta) segmentata. Is a colorful stretch spider that builds orb webs, and is often seen in late summer/autumn. The webs are built by the larger females who usually lie head down on the web, as in this photo, waiting for prey to get entangled in the web. The prey is then quickly captured 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.



AMERICAN HOUSE SPIDER
(Araneus diadematus)

Parson Spider

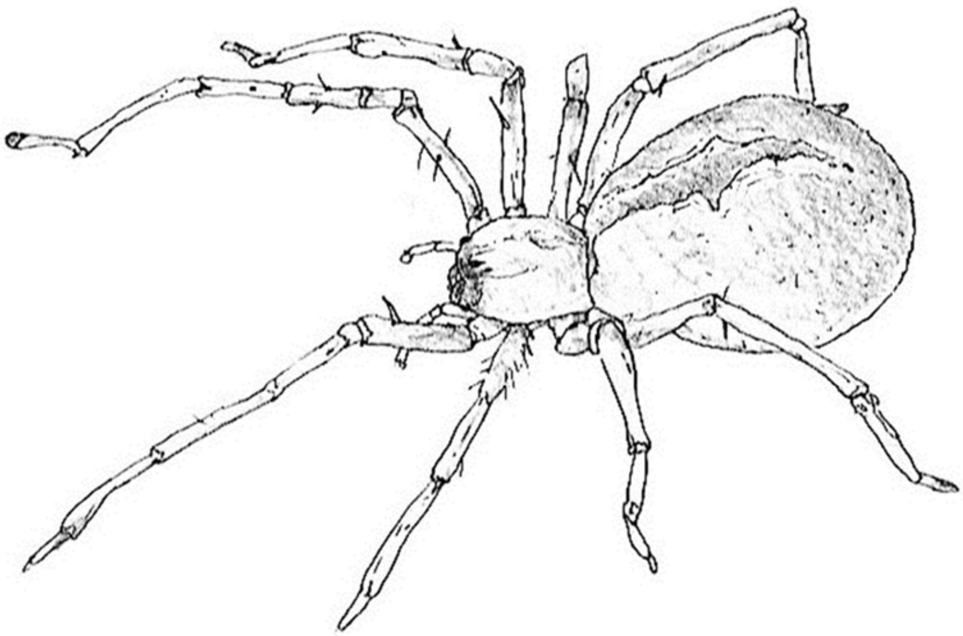


PARSON SPIDER

(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)

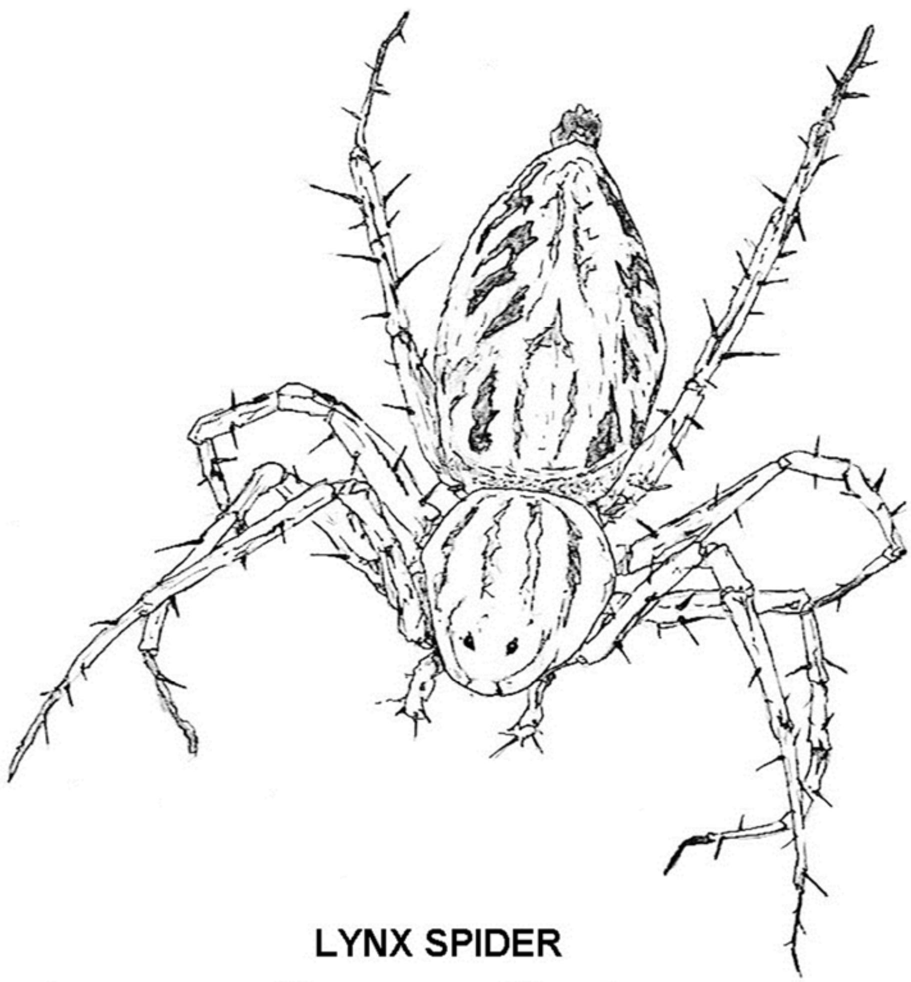
Sac Spiders

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.

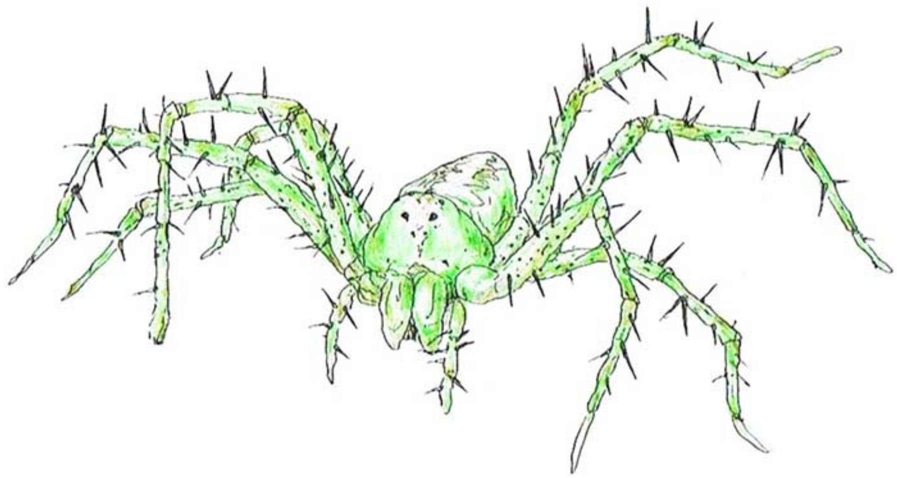
Crab Spiders

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.



LYNX SPIDER

(Oxyopes salticus)



GREEN LYNX SPIDER

(Peucetia viridans)

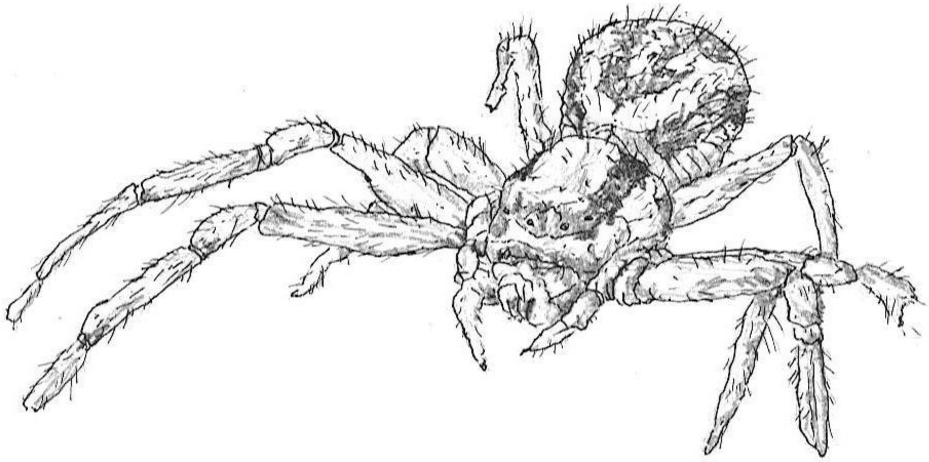
Peucetia viridans is one of the Lynx spiders. They catch their prey in several ways. They can run rapidly about plants and jump from branch to nearby branch,; and they can wait in ambush (like a wildcat) and drop down on their prey. This species has an interesting eye arrangement with two small eyes 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*").

The web of a particular Micrathena gracilis spider is shown above. The web is constructed in a vertical plane, and the spider hangs head downward in the center of the web when waiting for a prey.   The distance from left to right across the spirals is about 3 feet.

Gasteracantha cancriformis. This is a female orb weaving spider. Like Micrathena gracilis, it also has spines on its abdomen.

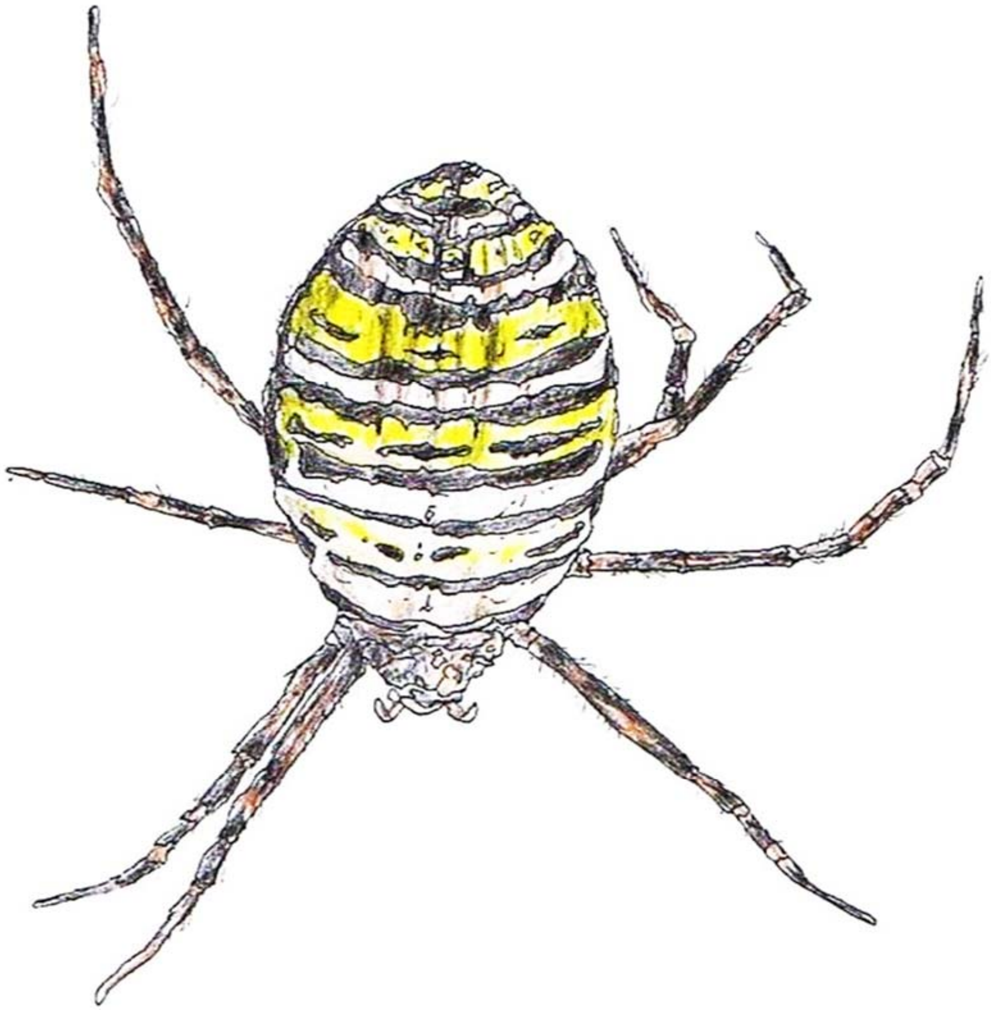


CRAB SPIDER ***(Misumenops Asperatus)***

One of the “flower spiders” (so-called because they generally hunt in similarlycolored 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.

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 here 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.

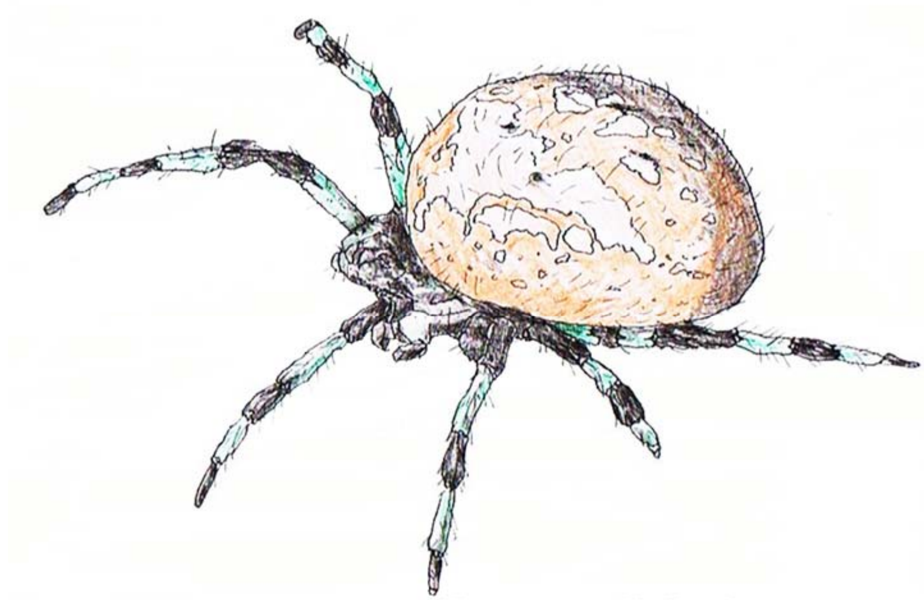
From the time a grasshopper lands in its web, it takes the spider just a few seconds to wrap the grasshopper in a shroud of silk and store it for later consumption. To illustrate how different names have been used, B. J. Kaston in "*The Spiders*," (William Brown Col. Publishers, Dubuque, Iowa, Second Edition, 1972) refers on page 172 to this spider as Argiope aurantia. Photo from Rusty Randall.



BANDED GARDEN SPIDER

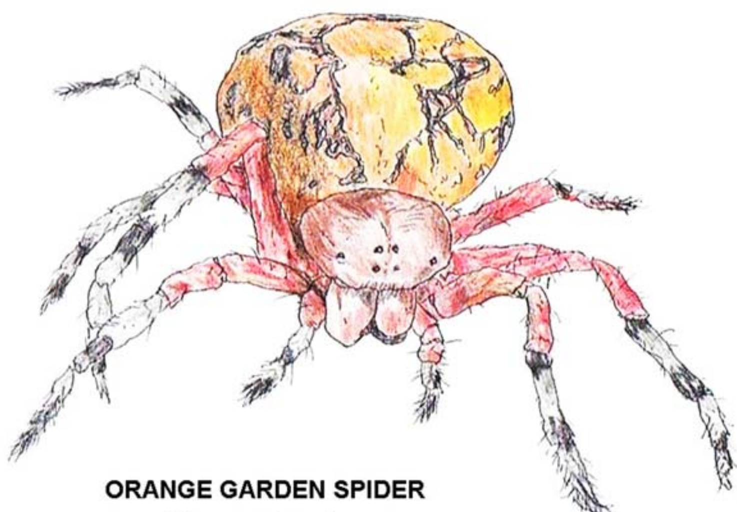
(Argiope trifasciata)

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.



SHAMROCK SPIDER *(Araneus trifolium)*

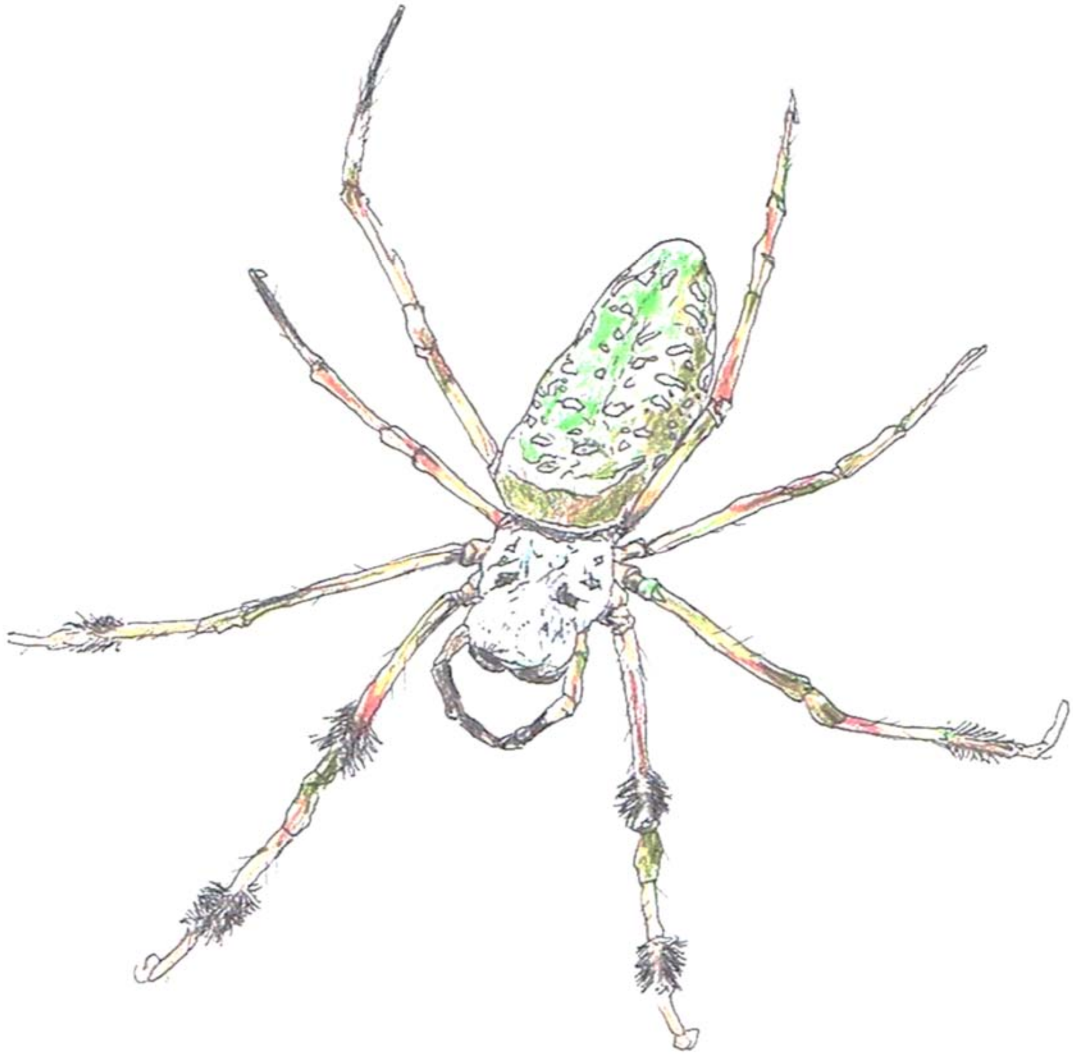
Aranea trifolium is commonly named the shamrock spider. She is a rather large orb-weaver. She is off-white with dark median longitudinal stripe and with dark marginal stripes. Legs are white to yellow with dark annulations. Abdomen off-white, reddish or purplish, sometimes greenish. Colored specimens usually with paired and unpaired angular white spots. venter dark, usually unmarked.



ORANGE GARDEN SPIDER

(Aranea gigas)

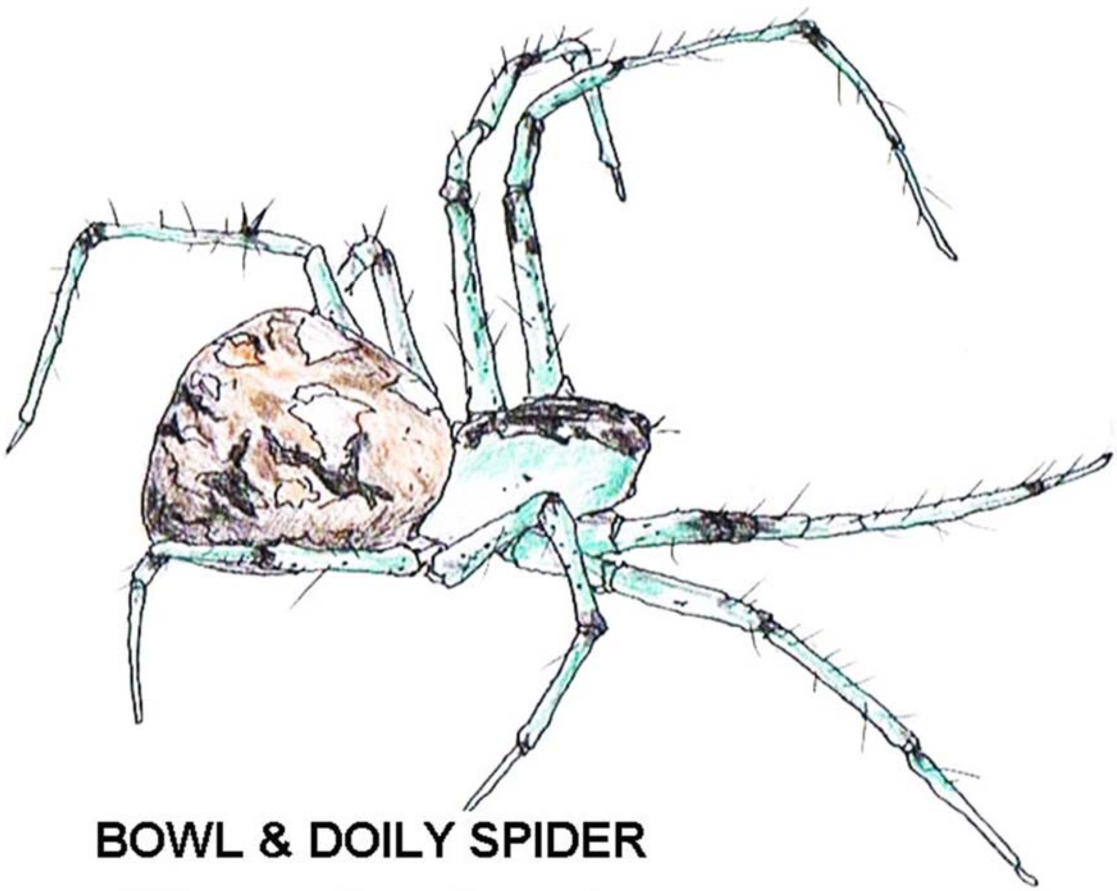
Hentzia basilica Those who have seen a spider of this species spin its web indicate that it first produces a horizontal orb having more than 50 radii; then it attaches numerous silk threads to the outer portions of the orb, pulls them downward, and anchors them; finally it connects numerous silk threads 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.



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.

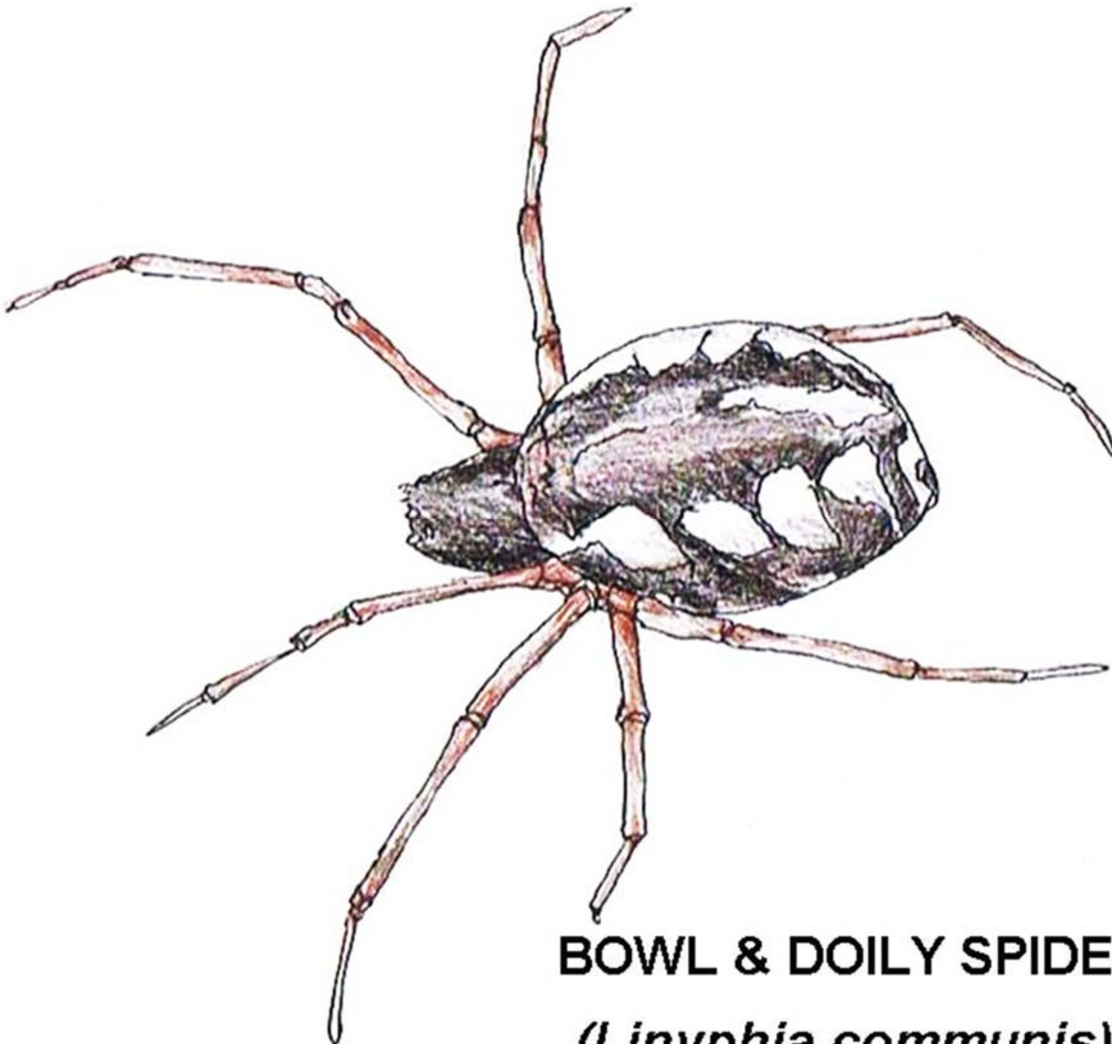
Tetragnatha elongata (Comstock, pp. 425-426) Has its chelacerae conspicuously extend forward. Its two fangs are at the ends of the two chelacerae. This is an orb-weaving spider that, unlike the orb weavers of most other genera, spins its web in a plane that is tilted about 45 degrees from the vertical and usually positions it near or over a body of water, such as a creek or lake.



BOWL & DOILY SPIDER

(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.

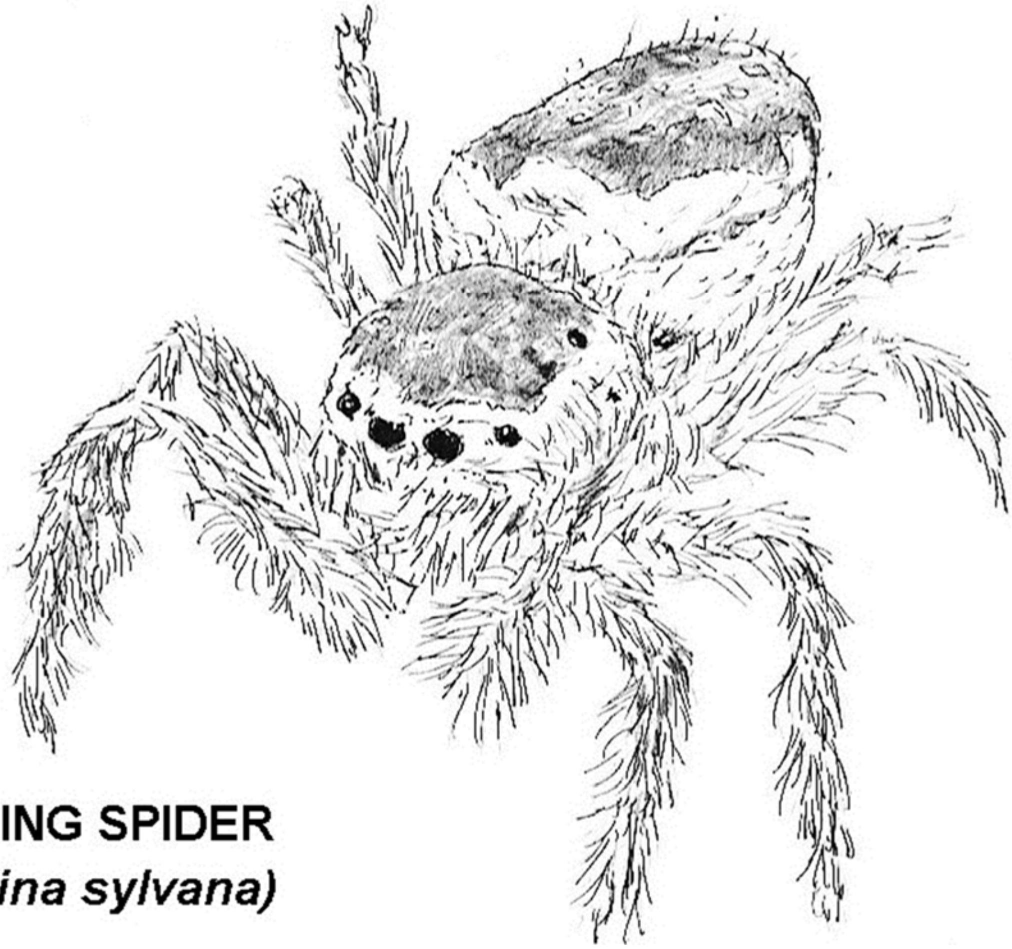


BOWL & DOILY SPIDER

(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 (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.

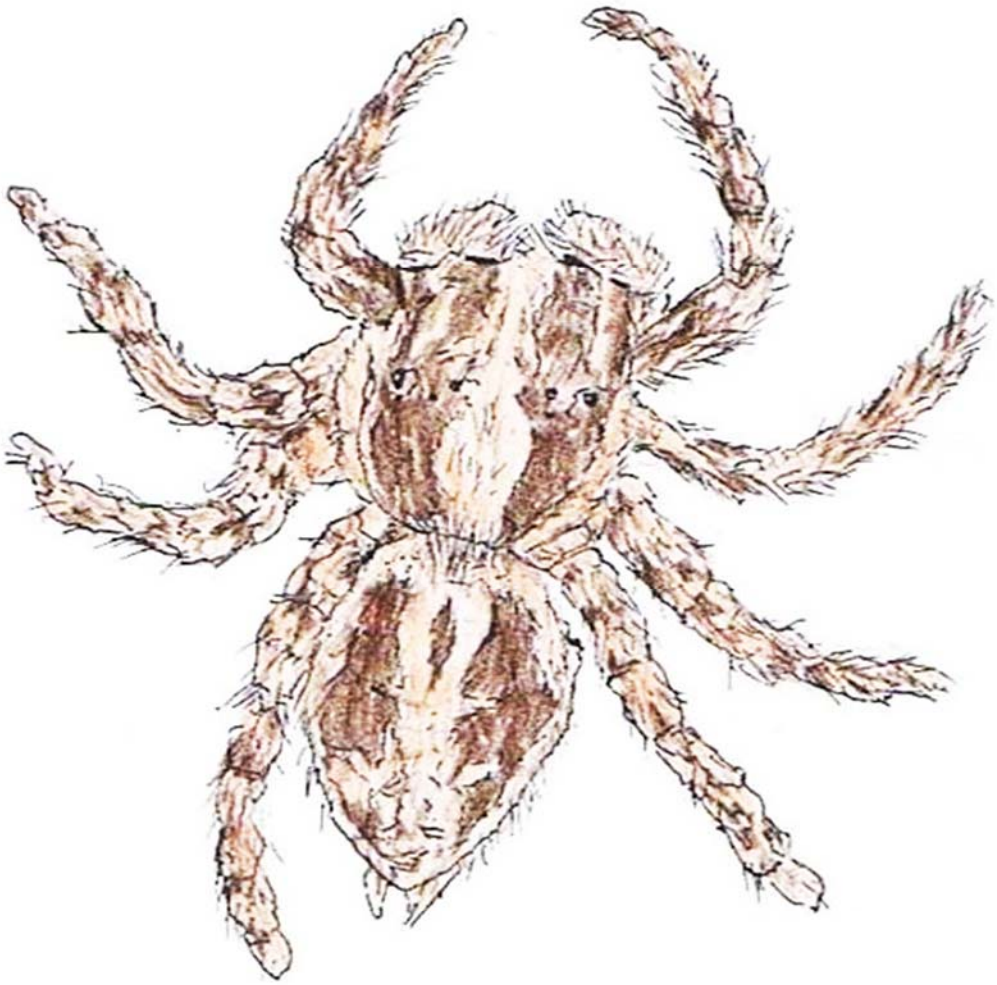


JUMPING SPIDER
(Thiodina sylvana)

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.

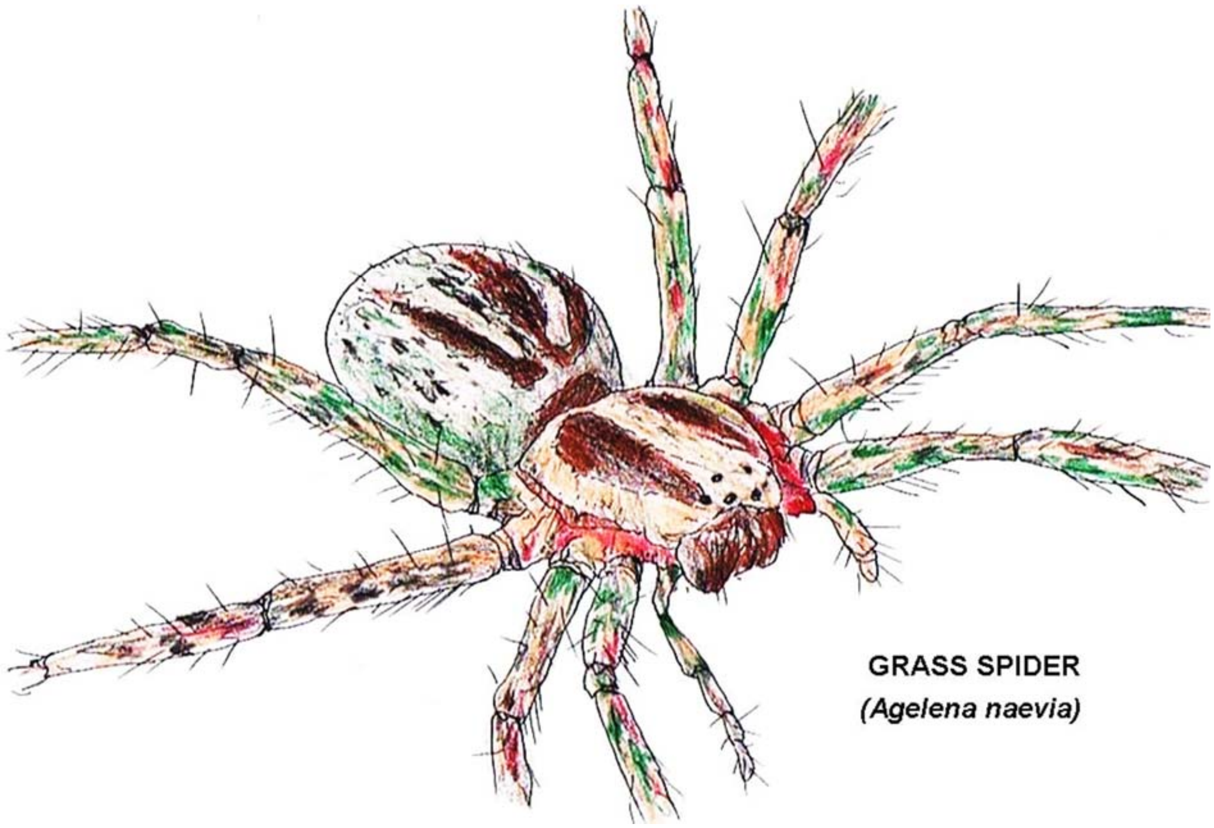
Phidippus clarus Spiders have eight legs, two chelicerae (the first two appendages of the head, here iridescent greenish-blue) having retracted fangs at their extremities, and two pedipalps, which are short appendages attached to the head on each side of chelicerae. Here, the tips of the pedipalps are 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.



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.

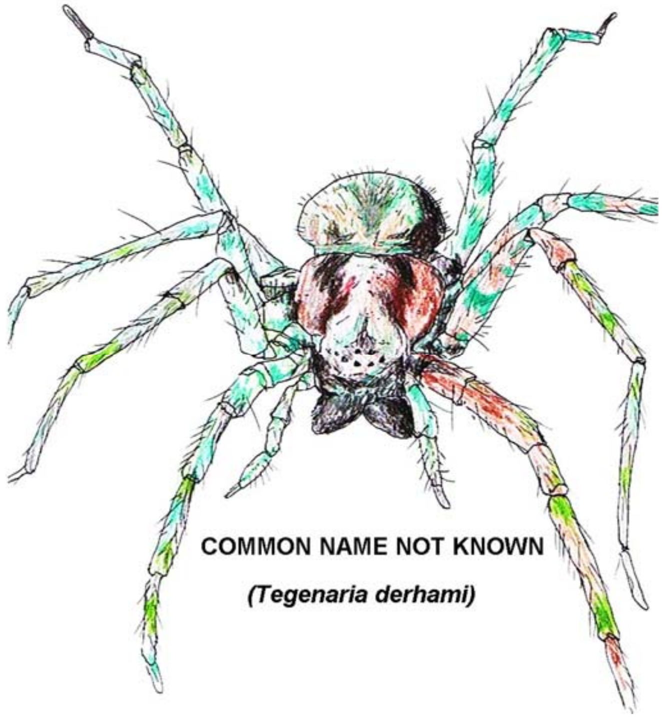
Hasarius adamsonii, a cosmotropical species, is likely a tropical species that arrived on a plant shipment. It is not in Professor Comstock's Spider Book.



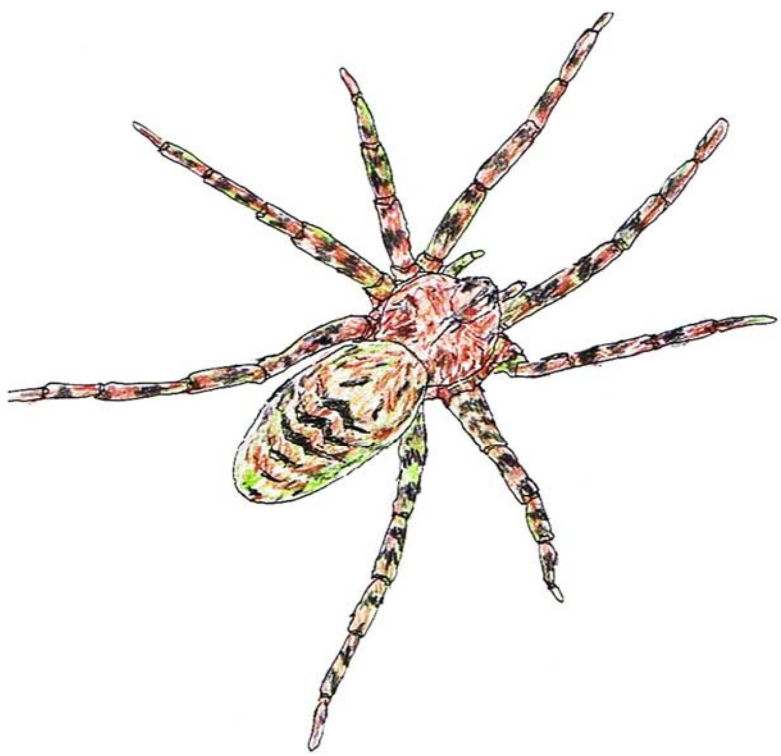
Agelena naevia is commonly called the grass spider. It constructs a web over which it can run quite rapidly. When waiting for prey, it resides hidden in the funnel portion at the upper left of center. When it detects that some part of its web has undergone at least a small relative motion, it emerges 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 arrangements 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.

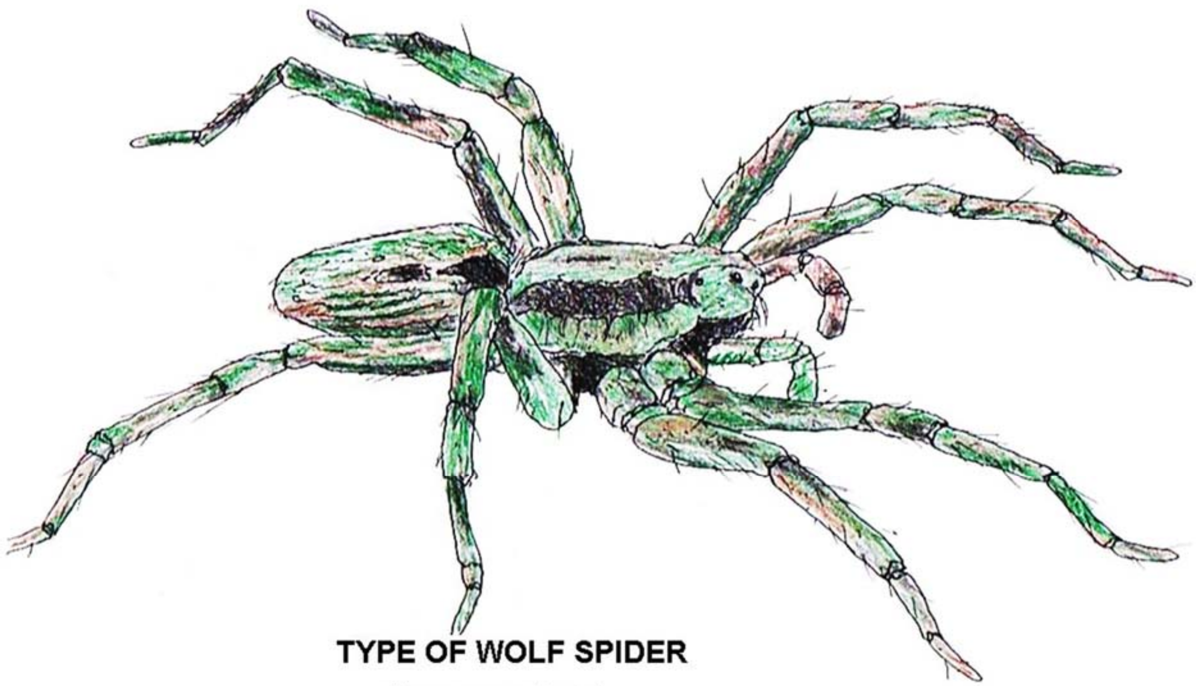


FISHING SPIDER

(Dolomedes tenebrosus)

Dolomedes tenebrosus is 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.

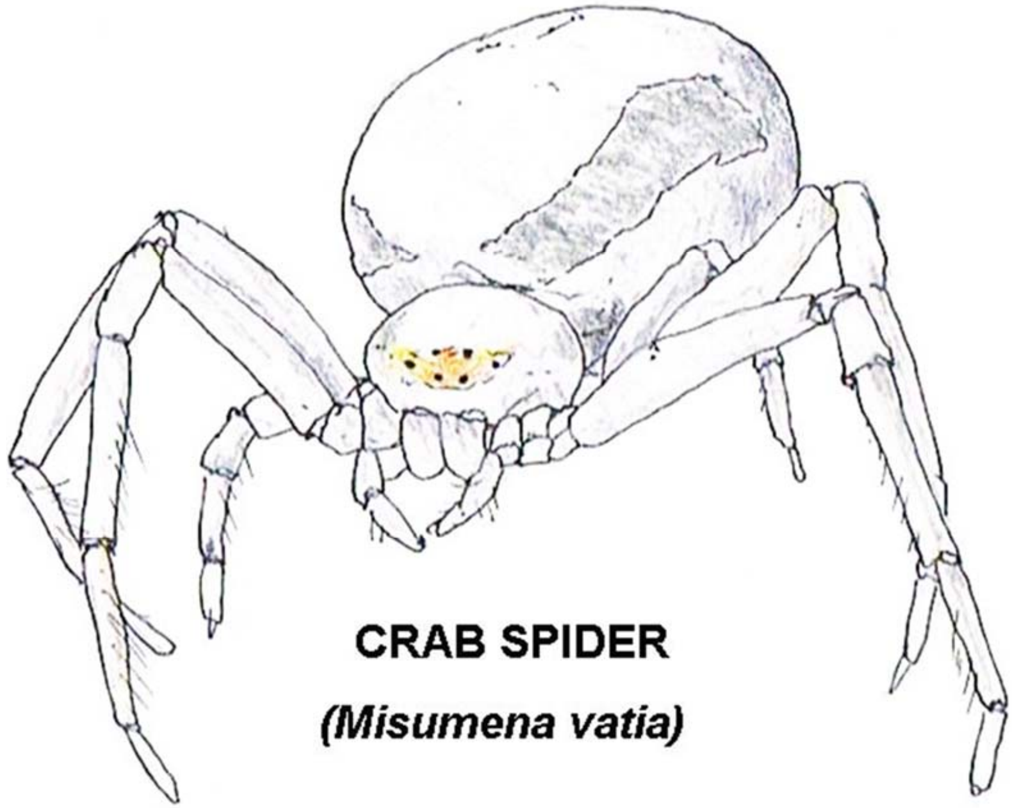
Lycosa aspersa It has four simple eyes in a fairly straight first row and four larger simple eyes behind them at the vertices of a trapezoid. (The shorter of the two parallel sides of the trapezoid is just behind the row of four smaller eyes.) It is a large spider that has excellent vision and can run 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.



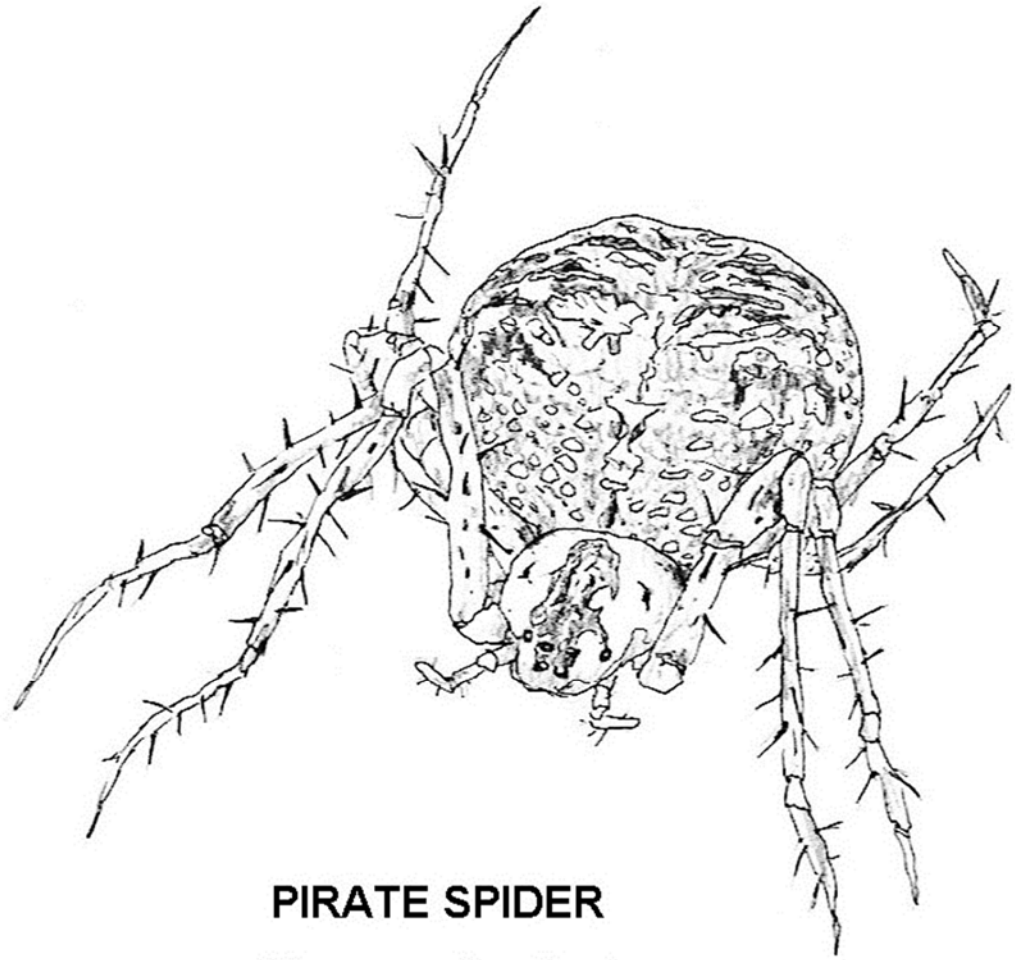
TYPE OF WOLF SPIDER

(Lycosa gulosa)

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.



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.

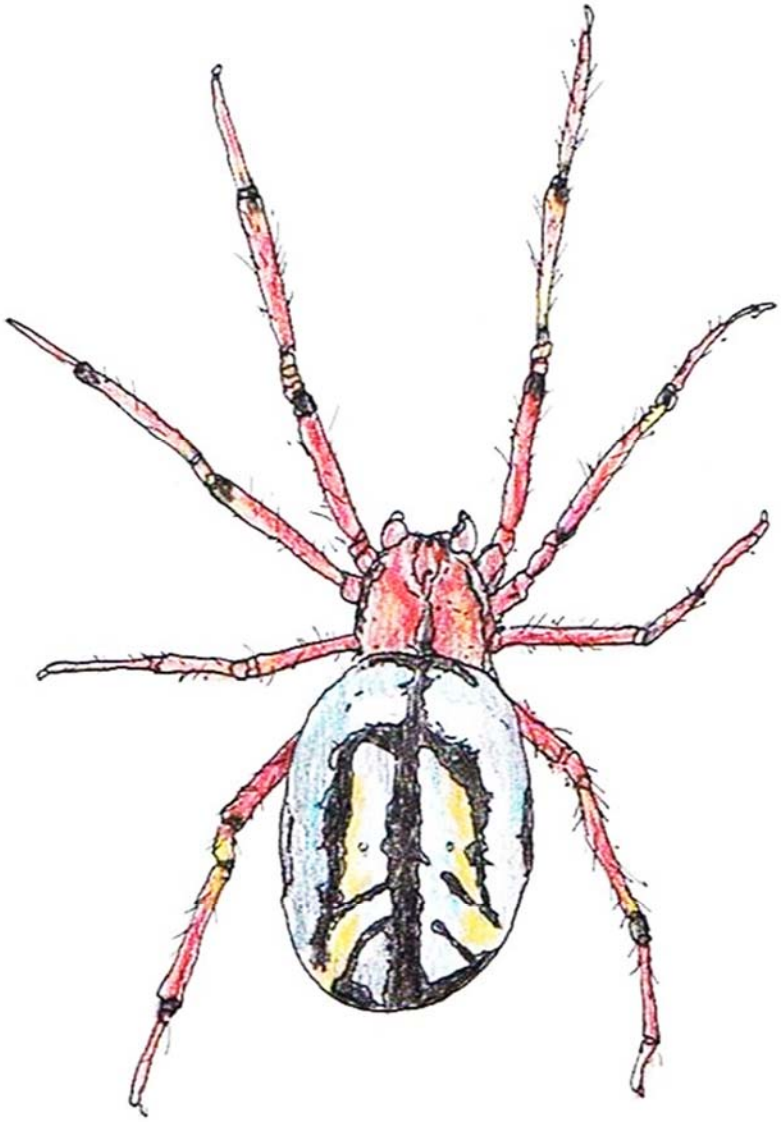


PIRATE SPIDER

(Genus mimetus)

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.

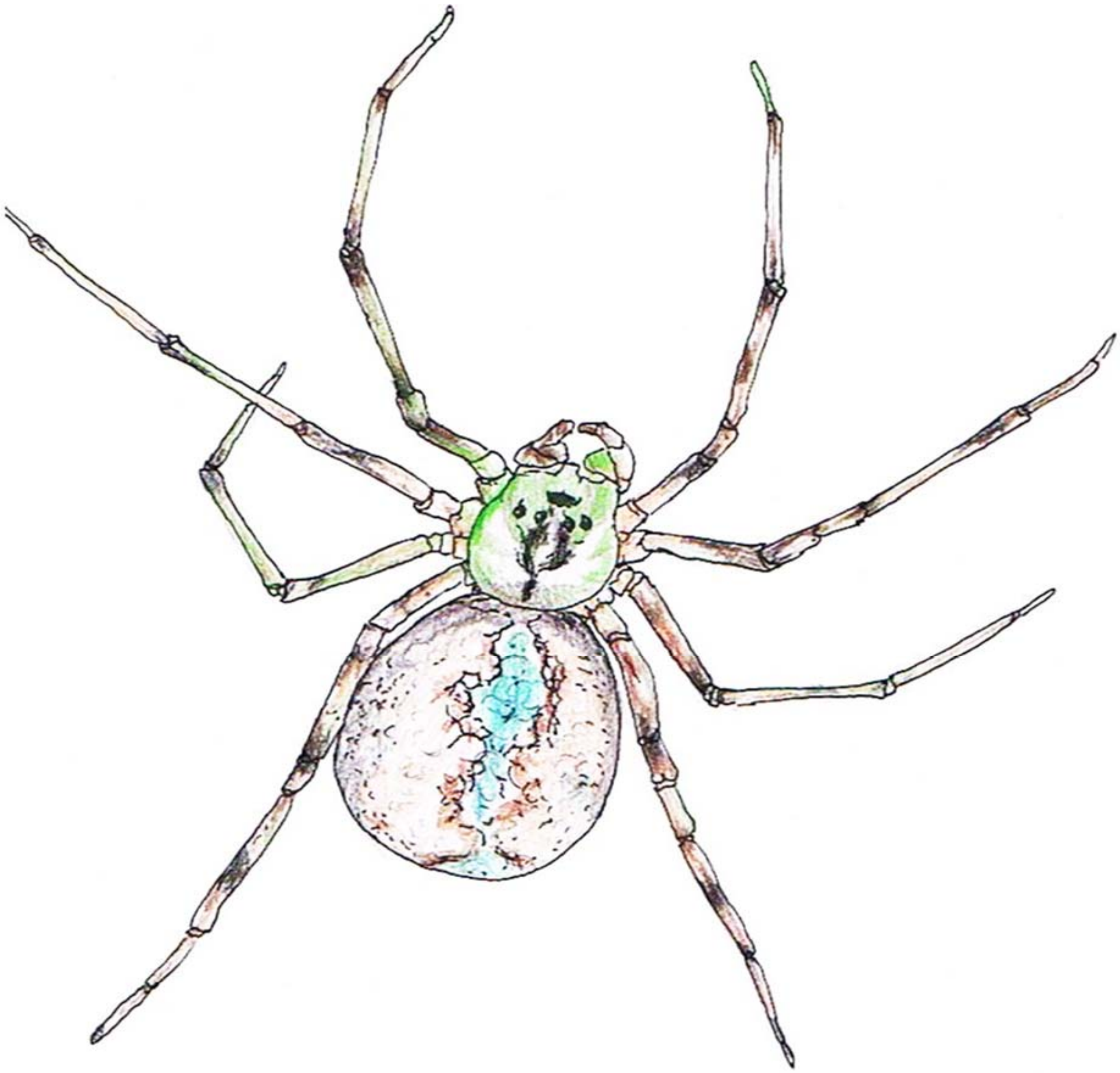
Mimetidae usually hunt other spiders by picking at the strands on their prey's web to simulate the movements of either a trapped insect or a potential mate. When their prey comes to investigate, they are instead captured and eaten. Some mimetids have been observed to feed on insects as well. The spider-feeding habit presents problems in mating, and little is known about how the males court females to avoid being eaten.



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 parasitised by a wasp larva, which attaches itself externally at the junction of the cephalothorax and abdomen.



HAMMOCK SPIDER

(Linyphia phrygiana)

This is a common group of small spiders (order Araneida), numbering about 2,000 species through out the world. Most are less than 6 mm ($^1/_4$ inch) in length and are seldom seen. Their webs are flat and sheetlike 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.

Spider Control Section

Ridding your home of insects will help discourage spiders from sharing your habitat, as will removal of webbing. Eventually, if no other food source happens into your house, control is inevitable. This takes time, immaculate cleanliness, and rigid pest control. Sometimes, spiders have to be chemically treated.

A consistent presence of spiders in structures may be a sign of an insect infestation, because spiders cannot survive long without food. Reducing insect infestations will also decrease spiders.

Most applicators have discovered that wettable powders and dusts work better than standard liquid pesticides for spider control. In unfinished basements, fan spray with a wettable powder on sill plates, and cracks and crevices throughout the rest of the house to provide excellent control. If the spider population is severe throughout the house, foggers may be in order in combination with the spraying for more immediate results.

For accidentally invading spiders (these are most frequent spider situations), we recommend that efforts be made to seal cracks and crevices as the most permanent solution.

Treat the perimeter of the building with Ficam W or equivalent, paying particular attention to corners and entry points. Ficam W is effective against all spiders, including the brown recluse, black widow, house, wolf, and garden spiders. Ficam W is odorless, has a low mammalian toxicity, and is especially effective against ants, millipedes, spiders, big roaches, carpenter bees, clothes moths, and scorpions.

- For continuous spider control, repeat this outside spraying each month.
- On the inside, an aerosol can be used to kill spiders quickly, and then use **Ficam W** or equivalent at maximum strength and low volume to keep the spiders from rebuilding their webs. It is very important to use a wettable powder pesticide formulation such as **Ficam W**. Using a garden-type spray will give you almost no residual because the spiders will rebuild their webs in the sprayed areas within just a few days after spraying with one of these emulsifiable water based sprays. For heavy infestations, you may also want to spray the attic and crawlspace.

In areas where insecticides should not be used (for example, boat docks and boat houses or in areas where access is difficult, for example, high rise buildings), then the use of Cobweb Eliminator or equivalent is recommended. This is a non-toxic spray that discourages spiders from building their webs on the areas sprayed.

Cobweb Eliminator: A product that eliminates cobwebs both indoors, outdoors, or anywhere cobwebs are noticed with 100% natural ingredients. Cobweb Eliminator will not stain and has no long lasting odor. The mildly acidic odor noticed after application indicates the product is effectively working.

This odor disappears usually in 24 hrs. Cobweb Eliminator deteriorates the webs' attachment points making for easy removal and maintains a neat, clean appearance. It also discourages the reformation of cobwebs. It is 100% natural, nontoxic, biodegradable, nonflammable, non-corrosive and safe around humans, pets, and crops, when used as directed.

Crack and Crevice (C/C)
When spiders 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, Crack and Crevice (C/C) means applying the chemical into the cracks and crevices suspected of harboring spiders. 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 spider control with nothing more if he or she knows where to do the application. With the use of *Drione Dust* or equivalent, applicators have solved many 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 1980s.

Although not as popular as when they first came out, aerosols offer a clean, ready-to-use formulation that is effective. PT-280 uses Orthene as an active ingredient, which is still the least resistant chemical available for pest 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.

Residual Sprays
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.

Water-based sprays 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 pests, pay particular attention to cracks and crevices. Exposed surfaces, especially those used to prepare foods, should usually not be treated with sprays.

Habit Modification
Habit modification is the most important tactic for good spider control. Whether indoors or outdoors, most spiders have a preference for undisturbed areas. Outdoors, remove debris near the building to disturb their natural habitat. Also, remove webs in outdoor areas, especially porches, under eaves, and other likely breeding places around the home. Inside, clutter in garages, basements, closets, and other storage areas should be removed.

Be sure to dust and vacuum frequently around windows, corners of rooms, shelves, under furniture, and behind mirrors and pictures. If you see sac spider capsules, remove them. It is a good idea to wear gloves when cleaning. Because most spiders enter houses through small cracks and crevices, sealing entry points with caulk will be the most permanent solution to spiders wandering inside in the late summer and early fall.

Glue Boards
If you are concerned about spiders inside your home, place sticky glue boards in the rooms where you are seeing spiders, especially on outside walls and in closets or secluded areas. Take captured spiders to someone who can identify them. Check with your local extension office or land-grant university. If you have an infestation of brown recluse spiders, you may want to work with a licensed pest control company—one who has experience treating structures for brown recluse infestations.

These nontoxic sticky boards are very useful to keep under your sinks and appliances at all times. They let you know if any ants, roaches, spiders, scorpions, lady bugs, box elder bugs, etc., have invaded your home.

Non-Chemical Spider Control
Eliminate or shield outdoor lights or bright indoor lights that attract flying insects.

Trim weeds around the building foundation and remove debris to discourage insects and spiders from living next to a structure.

Seal openings, and install screens and door sweeps to prevent spiders from moving indoors.

Use a vacuum to remove webs, spiders, and egg sacs.

Crab Spiders (*Thomisdae*) - 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 ferox--Crab Spider
'08
Pearce

Spider Bite 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.

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).

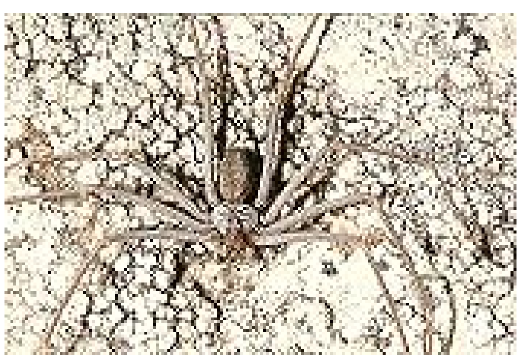
Sac spider bite.

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 colour 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 antivenom 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 subdermal 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.

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.

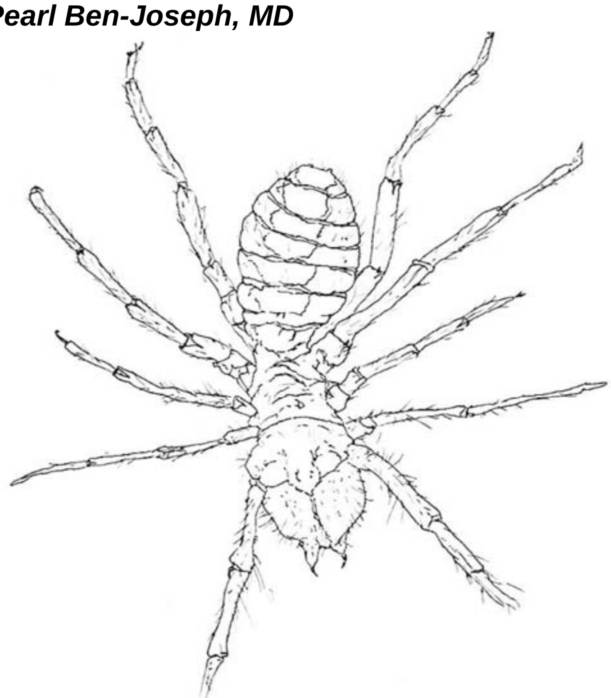
Tick Bites

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



CAMEL SPIDER *(Galeodes Toelgi)*

Spider Glossary

Abdomen: The posterior (rear) of the two major divisions of a spider.

Accessory claws: Serrated, thickened hairs near the true claws in some spiders.

Alveolus: A ventral depression in the male palp which receives the basal and middle divisions of the genital bulb. Although usually described as a cup-like depression, the alveolus is actually a ringed depression, the inner margin of which is joined to the basal haematodocha.

Anal tubercle: A small projection, dorsal to the spinners, carrying the anal opening.

Annulations: Rings of pigmentation around leg segments.

Anterior: Nearer the front or head.

Apex: Distal tip.

Apomorphy: Derived character.

Apical male palp: The conductor and the embolic subdivision comprise the apical division of the bulb.

Apophysis: An excrescence or appendage changing the general cylindrical or globular shape of a sclerite; most often used in description of male palp.

Atrium (pl. atria): Internal chamber at the entrance of copulation tract in female haplogyne spiders.

Ballooning: Aeronautical dispersing by means of air currents acting on strands of silk.

Booklung: An air-filled cavity, containing sacks of blood-filled leaves, opening on the underside of the abdomen.

Bronchial opperculum: A sclerotized, hairless plate overlying the book lung.

Bulbus: The genital bulb is the terminal segment of the palpus. It's a hollow organ with external elaborations. The bulbus is divided into three divisions: (1) Basal division, (2) Middle division and (3) Apical division.

Calamistrum: A comb-like series of hairs on metatarsus IV of cribbelate spiders.

Caput (pl. capita): Another name for the cephalic region of the cephalothorax.

Carapace: The exoskeleton covering, or shell, over the dorsal (upper) surface of the cephalothorax.

Cardiac mark: An elongate midline mark on the anterior, dorsal surface of the abdomen, overlies the heart.

Cephalothorax: The anterior (front) of the two major divisions of the body of a spider.

Chelicerae: The jaws, each one comprising a large basal part and a fang.

Chelate: Said of chelicerae in which the fang closes down on a tooth-like process.

Chilum (pl. Chila): Small sclerite at the base of chelicerae, just under the clypeus.

Chitin: A linear homopolysacheride found as the characteristic molecule in the cuticle of arthropods. The molecules are layered in chains and cross-linked to form a strong, lightweight basis of the cuticle.

Claw tuft: A bunch of hairs at the tip of the leg tarsus in spiders with only two claws.

Clypeus: The area between the anterior row of eyes and the anterior edge of the carapace.

Colulus: A small midline appendage or tubercle arising just in front of the anterior spinners in some spiders.

Conductor: A semi-membranous structure in the male palp, which supports and guides the embolus in insemination.

Condyle: A smooth, rounded protuberance sometimes present on the outer side of the chelicera, near its base.

Coxa (plural: Coxae): The segment of legs nearest the body, modified in the palp to form the maxilla.

Cribellum: A spinning organ just in front of the spinners, which appears as a transverse plate. Only present in cribellate spiders, which also have a calamistrum.

Cryptozoic: Living a concealed life.

Cymbium: The broadened, hollowed-out tarsus of the male palp within which the palpal organs are attached.

Diaxial: Said of chelicerae extending downwards with fangs closing towards midline.

Dionychous: Possessing two claws on tarsus.

Distal: Pertaining to the outer end, furthest away from the body or point of attachment.

Dorsal: Pertaining to the upper surface.

Dorsum: The upper surface.

Ecdysis: Molting; the periodic casting off the cuticle.

Ecribellate: Without a cribellum and calamistrum.

Edentate: Without teeth.

Embolus: The structure, in the male palp, containing the terminal part of the ejaculatory duct and its opening. It may be very small, or long, whip-like, or coiled; and is sometimes divided into several structures.

Endite: Basal segment of palp, also called the maxilla or gnathocoxa.

Entelegyne: The group of spiders in which the females have an epigyne.

Epigastric fold: A fold and groove separating the anterior part of the ventral abdomen (with epigyne and book lungs) from the posterior part.

Epigyne: A more or less sclerotized and modified external structure associated with the reproductive openings of adult females of most spiders.

Exoskeleton: The hard, external supportive covering found in all arthropods.

Exuviae: The parts of the cuticle cast off during molting.

Fang: The claw-like part of each chelicera; the poison duct opens near its tip.

Femur (pl. femora, adj. femoral): The third segment of the leg, counting from the body.

Fissidentate: Teeth having more than one point.

Folium: Any pattern of pigment on the dorsum of the abdomen that is fairly broad and leaf-shaped.

Fovea: A short median groove on the thoracic part of the carapace that marks the internal attachment of the gastric muscle.

Gnathocoxa (pl. gnathocoxae): Basal segment of palp, also called maxilla or endite.

Gossamer: A light film of silk threads, or groups of these floating through the air.

Haematodocha: A balloon of elastic connective tissue between groups of sclerites in the male palp that distends with blood during insemination, causing the sclerites to separate and rotate.

Haplogyne: The group of spiders in which the females have no epigyne.

Head: The part of the carapace carrying the eyes, which is separated from the thorax by a shallow groove.

Labium: The lip, under the mouth opening and between the maxillae, attached to the front of the sternum.

Lateral: Pertaining to the side.

Lanceolata: Tapering to a point.

Lyriform organ: A sensory organ near the distal end of limb segments formed of a group of parallel slit organs.

Maxilla: The mouthparts on each side of the labium, which are the modified coxae of the palps.

Median: In the midline or in the middle.

Median apophysis: A sclerite arising from the middle division of the male palpal organs.

Median septum: Longitudinal sclerite on floor of epigynal atrium.

Metatarsus (pl. Metatarsi): The sixth segment of the leg, counting from the body.

Onychium (pl. Onychia): Ventral extension of tip of tarsus bearing the claws.

Orb web: A two-dimensional web, roughly circular in design (and strictly speaking, a misnomer). Silk threads radiate like spokes from a central hub. These are then overlaid with a spiral of silk, running from the periphery almost to the hub.

Palp *short for the pedipalp*: The appendage arising just in front of the legs, the coxa of which also forms the maxilla. It has no metatarsal segment, and in adult males, is greatly modified for the transfer of semen.

Palpal organs: The more or less complex structures found in the terminal part of the adult male palp. They comprise groups of sclerites separated from each other and the cymbium by up to three haematodochae, and contain the semen reservoir which opens via ducts through the tip of the embolus.

Paracymbium: A structure in the male palp branching from, or loosely attached to, the cymbium.

Paraxial: Said of chelicera extending forwards, with fangs closing towards abdomen.

Patella (pl. Patellae): The fourth segment of the leg or palp, counting from the body.

Paturon: Basal segment of chelicera.

Pedicel: The narrow stalk connecting the cephalothorax and the abdomen.

Pheromone: A chemical secreted by an animal in minute amounts which brings about a behavioral response in another, often of the opposite sex.

Phylogenetic: Pertaining to evolutionary relationships between and within groups.

Pluridentate: Having more than one tooth.

Porrect: Said of chelicera directed forwards.

Posterior: Near the rear end.

Process: A projection from the main structure.

Procurved: Curved, as an arc, having its ends ahead of its center.

Prolateral: Projecting from, or on, the side facing forwards.

Proximal: Pertaining to the inner end; closest to the body or point of attachment.

Punctate: Covered with tiny depressions.

Rastellum (pl. rastella): Rake-like structure at extremity of chelicerae in Mygalomorpha, often reduced to a few strong spines; use for burrowing.

Receptaculum (pl. receptacula): See: spermathecea.

Recurved: Curved, as an arc, having its ends behind its center.

Reticulated: Like network.

Retrolateral: Projecting from, or on, the side facing backwards.

Rugose: Rough, wrinkled.

Scape (Scapus): A finger-, tongue-, or lip-like projection from the midline of the female epigyne.

Sclerite: Any separate sclerotized structure connected to the other structures by membranes.

Sclerotized: Hardened or horny; not flexible or membranous.

Scopula (pl. Scopulae): A brush of hairs on the underside of the tarsus and metatarsus in some spiders.

Scutum: A hard, often shiny, sclerotized plate on the abdomen of some spiders.

Septum: A partition separating two cavities or parts.

Serrated: Saw-toothed.

Seta (pl. setae): Hair-like, tapered, and flexible structures on legs and body (cf. spine and trichobothrium).

Sigillum (pl. Sigila): An impressed, sclerotized spot, often reddish-brown. Often present on the dorsal surface of the abdomen and marking points of internal muscle attachments.

Slit organ: A stress receptor in the exoskeleton.

Spermathecae: The sacs or cavities in female spiders that receive and store semen.

Spiderling: The nymphal or immature spider, generally resembling the adult, but smaller; fully mobile and no longer dependant on yolk.

Spine: A thick, stiff hair or bristle.

Spinners: Paired appendages at the rear end of the abdomen, below the anal tubercle, from the spigots of which silk strands are extruded.

Spiracle: The opening of the tracheae on the underside of the abdomen.

Sternum: The heart-shaped or oval exoskeletal shield covering the undersurface of the cephalothorax.

Stria (pl. striae): Paired depressions; usually three pairs of darkened stripes radiating from fovea.

Stridulating organ: A file-and-scraper for sound production; may be variously located on chelicerae, palps, legs, abdomen, and carapace.

Subadult: Almost adult; the last instar before maturity.

Synonym: Each of two or more scientific names of the same rank used to denote the same taxon. The senior synonym is the name first established.

Tapetum (pl. tapeta): A light-reflecting layer in secondary eyes; eyes appear pale in color; assumed to be used for nocturnal vision.

Tarsus (pl. Tarsi): The most distal (or end) segment of a leg or palp.

Taxon: Any taxonomic unit (e.g., family, genus, species).

Taxonomy: The theory and practice of classifying organisms; part of systematics, the study of the kinds and diversity of organisms.

Tegulum: Part of the male palp: a discoidal sclerite.

Tegument: External cuticular skin.

Thorax: That part of the cephalothorax behind the head region and separated from it by a shallow groove.

Tibia (pl. Tibiae): The fifth segment of the leg or palp counting from the body.

Tracheae: Tubes through which air is carried around the body and which open at the spiracles.

Trichobothrium (pl. Trichobotria): A long, fine hair rising almost vertically from a socket on the leg. Trichobothria detect air vibrations and currents.

Trochanter: The second segment of the leg or palp, counting from the body.

Unidentate: Having one tooth.

Ventral: Pertaining to the underside.

Vulva: Internal structure of female copulatory organs, including entrance ducts, spermathecae, and fertilization ducts (in entelegyne spiders); internal genitalia including ducts and spermathecae (in haplogyne spiders).

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.

Spider Section Post Quiz

1. Spiders are mostly terrestrial, of the______________, with four pairs of legs and a two-part body consisting of a cephalothorax, or prosoma, and an unsegmented abdomen, or opisthosoma.

2. The cephalothorax is covered by a shield, or________, and bears eight simple eyes.

3. On the underside of the head (the cephalic part of the cephalothorax) are two pairs of appendages, the anterior pair called____________ , and the second pair pedipalps, with which the spider captures and paralyzes its prey, injecting into it venom produced in the poison glands.

4. The spider then liquefies the tissues of the prey with a ____________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.

5. Arachnid book lungs are similar to the gill books of____________, 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.

6. 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________________.

7. 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_________________.

8. Females weave silk egg-cases, each of which may contain_______________. Females of many species care for their young, for example by carrying them around or by sharing food with them.

9. A minority of species are social, building communal webs that may house anywhere from a few to________________.

10. Social behavior ranges from precarious toleration, as in the aggressive widow spiders, to co-operative hunting and_________________.

Answers

1. Class Arachnida, order Araneae, 2. Carapace, 3. Chelicerae, 4. Digestive fluid, 5. Horseshoe crabs, 6. Air currents, 7. Short life spans, 8. Hundreds of eggs, 9. 50,000 individuals, 10. Food sharing

Common Pesticides Application Section

Many household products are pesticides.

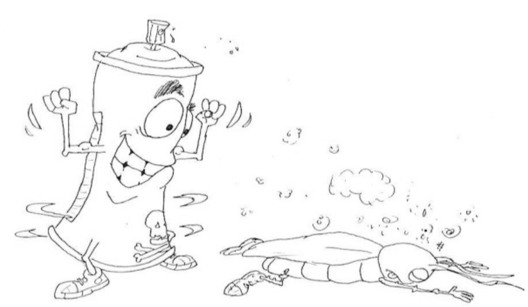
Did you know that all of these common products are considered pesticides?

- 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.

Antique glass bottle spray atomizer.



Various commercial pesticide products.

A handler employer 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.

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. Published in February 2000, the more detailed Chemical Safety Alert is available on the Web at: www.epa.gov/swercepp/p-small.htm#alerts. It is important that all pesticide establishments review this information and take appropriate steps to minimize risk. This document does not substitute for the EPA's regulations, nor is it a regulation itself. It cannot and does not impose legally binding requirements on the EPA or the regulated community, and 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 pesticides or chemicals. Elements of an effective security plan can range from basic fencing, lighting, and locks, to intrusion detection systems, cameras, and trained guards.

- **Securing Pesticide Application Equipment and Vehicles:** Facilities and pesticide businesses should ensure that they have appropriate security protection 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 pesticides or 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.

o 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 that have access to secure areas, particularly those areas where pesticides may be stored, are also necessary.

o 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.

o 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.

Timely Coordination with Authorities

If a breach of security or suspicious activity does occur, timely cooperation with authorities is crucial. In addition to cooperation with your local police department, the FBI requests that you expeditiously report any threats or suspicious behavior to your local FBI field office.

These agencies also must be informed if, as a registrant, you are made aware of any reports of adverse exposure under circumstances that are incongruous with your pesticide product's normal use pattern. Information on the location of the appropriate FBI office is available at www.fbi.gov.

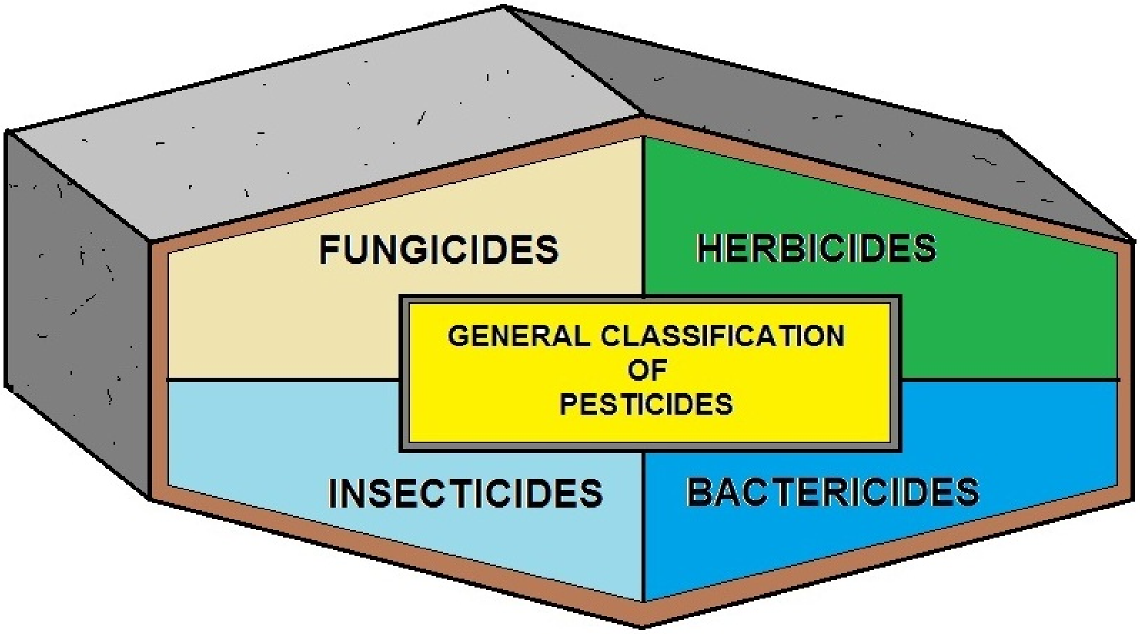
For More Information
The EPA and other Federal agencies have developed a variety of reference materials that may be helpful in reviewing the security of your business or operation.

- Many of the tips listed in this fact sheet are described in more detail in the Chemical Safety Alert entitled: A Chemical Accident Prevention: Site Security, @ published by the EPA on February 2000 and available on the EPA Web site at: www.epa.gov/
- For information on other Agency programs to promote facility security and readiness, visit http://www.epa.gov/
- DOT has produced a separate advisory for transporters, available by contacting DOT at 202-366-6525.

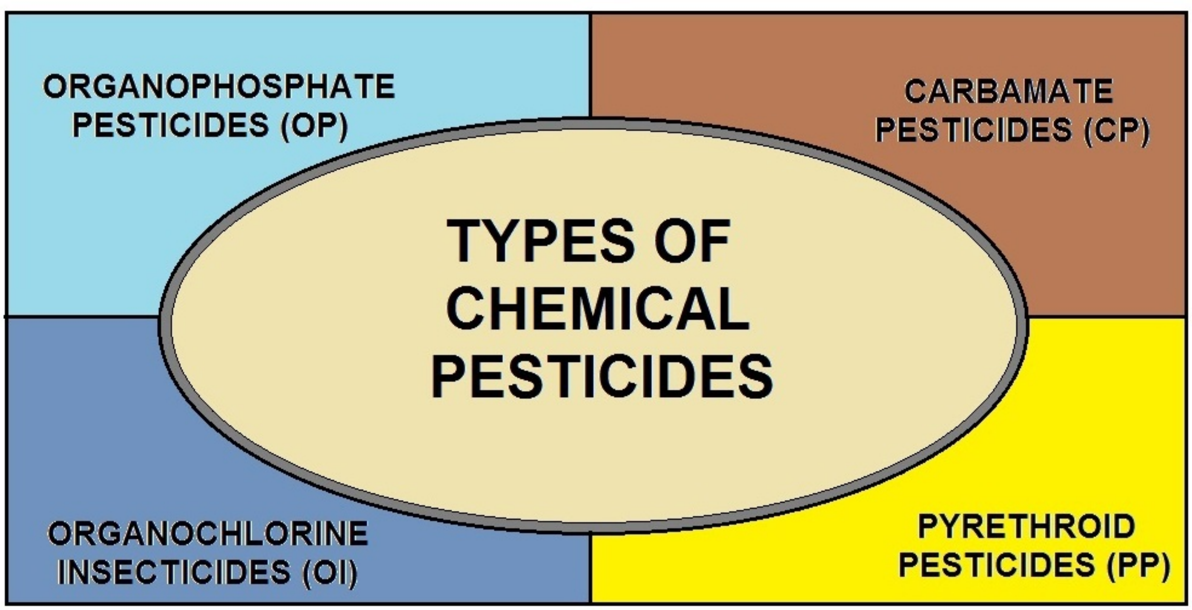
For objective science-based information about a variety of pesticide-related subjects, including pesticide products, recognition and management of pesticide poisonings, toxicology, and environmental chemistry, contact the National Pesticide Information Center (NPIC). NPIC, a toll-free hotline funded, in part, by the EPA, lists state pesticide regulatory agencies and provides links to their Web sites.

NPIC can be contacted at: 1-800-858-7378, by e-mail at npic@ace.orst.edu, or by visiting the Web at: http://npic.orst.edu/. Pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest.

Pests can be insects, mice and other animals, unwanted plants (weeds), fungi, or microorganisms like bacteria and viruses. Though often misunderstood to refer only to *insecticides*, the term pesticide also applies to herbicides, fungicides, and various other substances used to control pests. Under United States law, a pesticide is also any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.



CLASSIFICATION OF PESTICIDES



TYPES OF PESTICIDES

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.

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.

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)."*

Garlic, a natural pesticide

Antimicrobial Pesticides

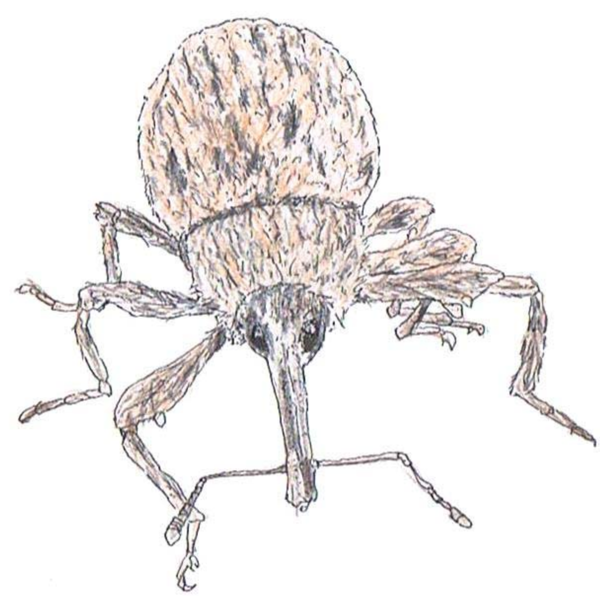
Antimicrobial pesticides, such as disinfectants & sanitizers, are pesticides that are intended to "(i) disinfect, sanitize, reduce, or mitigate growth or development of microbiological organisms; or (ii) protect inanimate objects (for example floors and walls), industrial processes or systems, surfaces, 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*



BOLL WEEVIL

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.

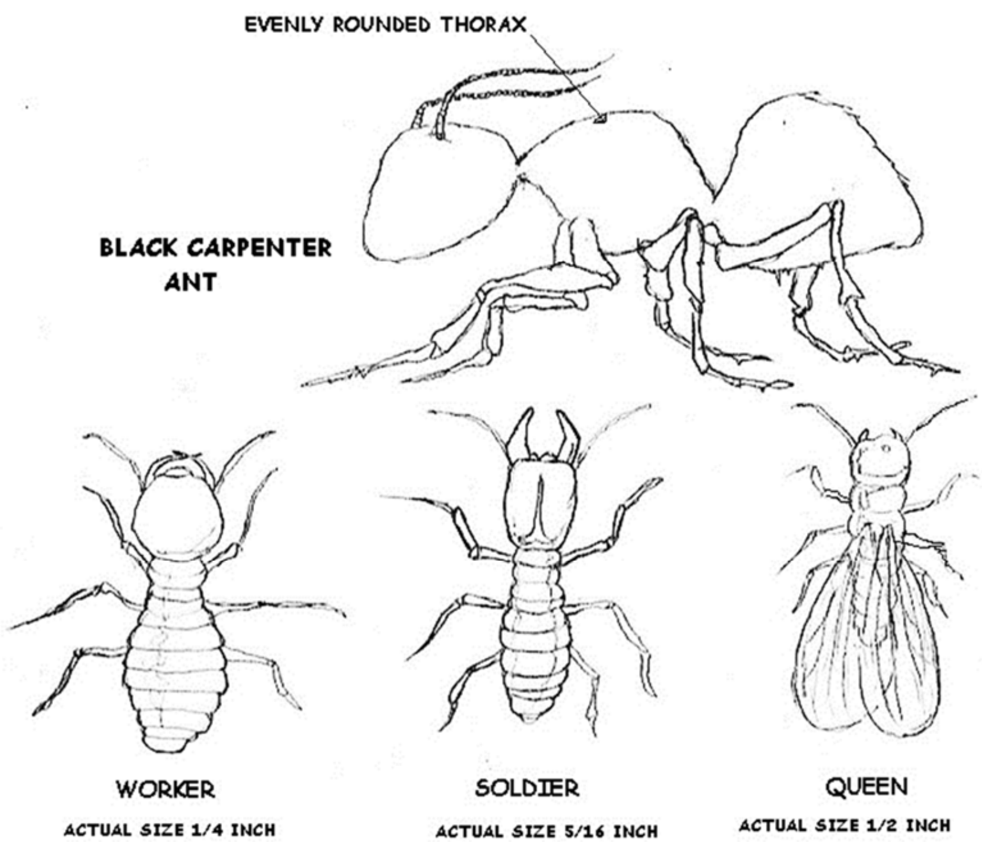
What are the advantages of using biopesticides?
Biopesticides are usually inherently less toxic than conventional pesticides.

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.

How does the EPA encourage the development and use of biopesticides?
In 1994, the Biopesticides and Pollution Prevention Division was established in the Office of Pesticide Programs to facilitate the registration of biopesticides. This Division promotes the use of safer pesticides, including biopesticides, as components of IPM programs. The Division also coordinates the Pesticide Environmental Stewardship Program (**PESP**). Since biopesticides tend to pose fewer risks than conventional pesticides, the EPA generally requires much less data to register a biopesticide than to register a conventional pesticide. In fact, new biopesticides are often registered in less than a year, compared with an average of more than 3 years for conventional pesticides.

While biopesticides require less data and are registered in less time than conventional pesticides, the EPA always conducts rigorous reviews to ensure that pesticides will not have adverse effects on human health or the environment. For the EPA to be sure that a pesticide is safe, the Agency requires that registrants submit a variety of data about the composition, toxicity, degradation, and other characteristics of the pesticide.



Ant verses Termite

Common Pesticide Applications and Methods

Hand Operated Sprayers
Hand operated applicators are generally used to apply small quantities of pesticides both inside structures such as greenhouses or for small jobs outdoors such as on small farms or spot treatment on larger farms.

Hand-held sprayers usually have an air pump which compresses air into the tanks and pressurizes the spray mixture. The pressure slowly drops as the liquid is sprayed. When the pressure gets too low, the nozzle spray pattern is poor. You must stop spraying and pump to rebuild the pressure. These sprayers operate at low pressures of 350 kPa (50 psi) or less and have small tanks of up to ten liters.

Back-pack sprayers are fitted with a harness so the sprayer can be carried on the operators back. Tank capacity may be as large as 20 liters. A hand lever is continuously operated to maintain the pressure which makes the back-pack sprayer output more uniform than that of a hand-held sprayer. Basic low cost backpack sprayers will generate only low pressures and lack features such as high-pressure pumps, pressure adjustment controls (regulator) and pressure gauges found on commercial grade units.

Basic low pressure hand operated sprayers are suitable for high-volume or dilute spraying where uniform coverage is not required. Sprayers equipped with pressure regulators and gauges and high pressure pumps (above 550 kPa or 80 psi) may be used for applying insecticides and fungicides.

Obtaining uniform coverage of an area is difficult with a hand operated sprayer. The operator must move the nozzle from side to side with proper overlaps and move at a steady pace. Motorized sprayers typically produce more consistent sprayer outputs, cover the spray swath more uniformly, operate at constant speeds and result in much more uniform coverage than hand spraying. Motorized sprayers are also capable of higher pressure sprays where required to provide better coverage.

There are many other types of hand operated sprayers that are not widely used throughout the agriculture industry. Some may be used extensively for the production of specific commodities.

Motorized Sprayers
Motor powered sprayers offer many advantages over hand operated sprayers. Powered sprayers can provide high pressure sprays and the power can be used to drive agitation systems, fans for air-assisted or airblast spraying and transporting large volumes of spray mix. Properly equipped and operated, power sprayers can provide uniform coverage on a wide variety of targets. These systems can be mounted on tractors, trucks, trailers, and aircraft. Some backpack sprayers are also motorized.

Boomless Sprayers
Motorized sprayers may be used to supply spray mix to a hand gun or hand held boom with several nozzles. With this equipment, the spray uniformity will be similar to a hand operated sprayer. However, the sprayer pressure may be constant and the operator is able to cover larger areas or targets than with a hand operated sprayer. Hand guns are useful for spot treatments and treating small areas.

Boomless Nozzles are also used to broadcast pesticides in areas not easily accessed by a boom sprayer. With this equipment good distribution of spray is obtained but the uniformity is not as good as with a properly operated boom sprayer. Boomless nozzles may be suitable for use in rough areas, and along fencelines and roadsides.

Boom Sprayers
Most sprayers distribute pesticides using a boom with spray nozzles spaced at regular intervals. The most common example would be wide horizontal booms used on field sprayers to spray field crops. Depending on how the motorized sprayer is equipped, these sprayers can be used for a wide variety of tasks. A high degree of spray coverage uniformity is possible with constant spray pressure through uniformly spaced nozzles traveling at constant speeds.

Boom Sprayers

Low pressure boom sprayers are often used for spraying herbicides and in some circumstances insecticides and fungicides. Insecticides and fungicides are often applied to larger plants with more foliage and may require finer droplets to obtain good coverage of the foliage, especially if the target is the undersides of leaves in dense canopies. High pressure boom sprayers are often used in these circumstances. High pressure sprayers require pumps, hoses, nozzles and other components that can develop and withstand the higher pressures, resulting in sprayers that are more expensive.

Sometimes sprayer booms are mounted vertically to spray some crops such as blueberries, raspberries and occasionally nurseries. Nozzle spacing and the boom distance from the target are important in both horizontal and vertical booms to achieve good coverage.

Airblast sprayers

Airblast Sprayers
Most boom sprayers rely on pressure to move the spray mixture through a small opening in the nozzle and to create the small droplets and speed necessary to achieve good spray coverage of the target. In field crops good coverage is relatively easy to achieve where the target foliage is small and close to the nozzles. In tree fruits, especially with large trees, good coverage with conventional sprayers is more difficult to achieve. Airblast sprayers direct the spray mixture from the nozzles into an air stream which transports the spray droplets to the target. Airblast sprayers have a powered fan which forces air through an opening to generate high air speeds. Often the opening or manifold can be adjusted to ensure that the air stream is directed at the target. These sprayers are also used in other commodities such as grapes, blueberries and nursery crops among others.

In conventional airblast sprayers most of the air movement is upward into the trees or target. Tower air manifolds are also available for airblast sprayers which direct the air horizontally or even downwards towards the target. The horizontal or downwards air movement minimizes drift from airblast sprayers.

Tower Sprayer

Granular Applicators
Granular applicators are used to apply granular pesticides to soil. Granules must be incorporated (mixed in with the soil) during or immediately following applications. Incorporation in the soil prevents birds from eating the granules; also, contact with soil moisture activates the pesticide.

There are several types of equipment for granular application. Some granular applicators can be hand operated and may use gravity to deliver the granules while others are powered such as the pneumatic applicators which use a stream of air to carry granules through the delivery tubes.

Aerial Applicators
Some pesticide labels say the pesticide can be applied by either fixed-wing aircraft or by helicopters. The main advantage of aerial spraying is that it can be carried out quickly and at times when ground equipment cannot operate. The main disadvantage is the increased possibility of pesticide drift onto neighboring areas and decreased spray coverage.

Even when properly calibrated and operated, aircraft sprayers are often not as thorough in applying material as ground rigs, especially to the lower surfaces of the leaves and to the lower portions of the plants when the foliage is dense.

Aerial applications should not be used for small acreages or in residential areas, and should be done only by properly trained individuals who hold a valid pesticide applicators certificate. Information on aerial applicator courses and pesticide applicator certificates can be obtained from your state pesticide department.

Other Applicators
There are many other types of pesticides applicators. Many are specialized applicators or have not been widely adopted. There are many variations on the type of equipment that has been described as well. Very high pressure sprayers, foggers and misters are used in the greenhouse sector to apply very fine droplets in an enclosed building. This equipment is also used in mushroom production and other situations with enclosed areas.

Pest Resistance

Pesticides are important pest management tools. Many pesticides have gradually lost their effectiveness due to the development of resistance by pests they once controlled. Pest resistance is an heritable and significant decrease in the sensitivity of a pest population to a pesticide that is shown to reduce the field performance of pesticides.

Pests may include insects, mites, weeds, and fungi and bacteria which cause plant disease. The management of pesticide resistance development is an important part of sustainable pest management and this, in conjunction with alternative pest management strategies and Integrated Pest Management (IPM) programs, can make significant contributions to reducing risks to humans and the environment.

An important pesticide resistance management strategy is to avoid the repeated use of a particular pesticide, or pesticides that have a similar target site of action as the pest control mechanism in the same field.

One pest control strategy is rotating pesticides and/or using tank mixtures or premixes with different mode/target sites of action. This will delay the onset of resistance, as well as slow the development and subsequent buildup of resistance, without resorting to increased rates and frequency of application, and ultimately, will prolong the useful life of many pesticides.

A resistance management strategy should also consider cross-resistance between pesticides with different modes/target sites of action. Pests may develop cross-resistance to pesticides based on mode/target site of action.

Insect Growth Regulators

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.

Human Health

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.

PILOT DOING PRE-FLIGHT CHECKS ON NOZZLES

IPM Methods (Types of Pest Control)

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

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.

Adjuvants

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.

Personal Protection From Pesticides

Pesticides enter the body through:
a) ingestion/swallowing through the mouth, accidental or deliberate;
b) dermal, through the skin when handling, measuring and pouring;
c) inhalation of small particles or dust when handling, spraying and flagging.

Of the above three routes, dermal exposure is the most common hazard. Avoiding exposure by the use of appropriate protective clothing and equipment (PPE), and paying attention to personal hygiene by washing exposed parts of the body after work and before eating, smoking and toileting will minimize risk. Personal protective equipment must be selected in accordance with the label recommendation. It must be comfortable to wear/use and be made of material, which will prevent penetration of the pesticide.

Where undiluted formulations are applied as ULV sprays, specific PPE requirements are stated on the product label. ULV treatments require PPE, which is approved for the particular product in use. PPE must bear an approval mark and should be comfortable to wear and not restrictive in use. The material used for PPE manufacture must prevent penetration of the particular formulation to be used (break-through time). PPE will only remain efficient if it is correctly maintained. Where damaged, repairs must restore it to its original specification and if this is not possible the item must be replaced.

Respirators must be checked on a regular basis and filter elements replaced in accordance with the manufacturer's instructions.

The operation of an airstrip involves additional safety considerations. As well as PPE for the ground crew and Crop Advisors, Workers Handlers, and, appropriate fire extinguishers must be provided for both the aircraft and the airstrip. The pilot must have a crash helmet and an approved safety harness for cockpit use and a respirator/fresh-air mask.

Pesticide Application Section
Pre-application
Time taken to check spray equipment before use will reduce costly delays when the season begins. Pre-season operational checks can be carried out with clean water but safety clothing should always be worn. Any checks suggested in this publication will be additional to the procedures specifically laid out by the equipment manufacturers in their user instructions.

Spray Equipment
It is essential that the equipment is appropriate for the pesticide formulation to be sprayed.

Conventional aqueous solutions are applied through hydraulic systems but where materials are to be applied undiluted (ULV), suitable atomizers must be fitted to the spray booms instead of nozzles.

Pumping and plumbing layouts are common to both application techniques but certain system components may have to be changed in cases where an aircraft is used for ULV spraying. Liquid flow rates for ULV spraying are lower than those for conventional spraying so that aircraft using this method require to be fitted with a spray liquid flow meter.

Proper Pesticide Handling

If improperly used, pesticides can poison people, pets and livestock. They also can damage beneficial insects, birds, fish and other wildlife; harm desirable plants; and they may contaminate soil and groundwater. It is necessary to maintain careful and continuous control over the use and handling of these chemicals during the transport, storage, mixing, loading, application and disposal. Care must be exercised in cleaning equipment, clothing, and persons working with pesticides. Additionally, special precautions are necessary if pesticides are spilled or catch fire. Certain materials associated with vector control operations, including some pesticides, are considered by EPA and DPR to represent hazardous wastes..

Transporting Pesticides
Pesticides can present a particularly severe hazard if they are involved in accidents during transportation. When pesticides are spilled on the roadway, they may catch fire, be scattered by passing cars and trucks, be blown by wind onto nearby crops or people, or be washed into ditches or streams by rain. If they catch fire, the fumes and smoke may injure fire fighters, police, and people far removed from the scene of the accident.

Even under relatively uneventful circumstances, pesticides may simply contaminate the vehicle, cargo, or people transporting the chemicals. When you transport pesticides, you are legally responsible for them.

To reduce the likelihood of pesticide spills or exposure of workers riding in vehicles transporting pesticides, the following guidelines should be followed:
1. Pesticides are most safely transported in the beds of trucks.
2. Pesticides should never be transported in the passenger compartment of any vehicle.
3. People should never be allowed to ride in the beds of pick-up trucks carrying pesticides. This applies especially to children as passengers.
4. Pesticides should never be transported in the same compartment with food, feed, or clothing.
5. All pesticide containers in shipment should be secured tightly. This is especially critical for glass containers.
6. Pesticide containers made of paper, cardboard, or similar materials should be protected from moisture during transport.
7. Pesticides in parked service vehicles must be made secure from theft, tampering, and contamination.

More on Storing Pesticide
It is necessary and legally required that pesticides be stored in a safe, secure and well-identified place. Here are some rules which pertain to pesticide storage:
1. Always store pesticides in their original, labeled container with the label clearly visible.
2. Always store pesticides in tightly sealed containers and check containers periodically for leakage, corrosion breaks, tears, etc.
3. Always store pesticides where they are protected from freezing or excessive heat.
4. Always be certain that pesticide storage areas are well-ventilated to prevent the accumulation of toxic fumes.
5. Always store different types of pesticides in different areas, to prevent cross contamination and the possibility of applying a product inadvertently.
6. Never store pesticides in old bottles or food containers where they could be mistaken for food or drink for humans or animals.

7. Never store pesticides near food, feed, or seed.

8. Agencies or programs that store significant amounts of pesticide should have a designated pesticide storage facility.

Requirements for Pesticide Storage:

1. Locking doors
2. Adequate lighting
3. Adequate ventilation
4. Fire extinguishers readily available
5. Spill containment design or equipment
6. Warning placards if Category I or II pesticides are stored – including emergency contact information
7. Personal protective equipment readily available
8. Wash water and eye wash stations available
9. Presence of label and MSDS book for stored materials

Recommended for pesticide storage:

1. Fire resistant construction
2. Emergency shower station
3. Spill containment floor design or drum pallets

Mixing and Loading Pesticides

All pesticides are potentially harmful, particularly for those who work with them on a daily basis because of the potential for being exposed to large doses and the likelihood of chronic exposure. Many pesticide accidents occur when the chemicals are being mixed for use. In California, one of the most dangerous jobs related to pesticide-related illness, is the mixing and loading of concentrated chemicals, specifically low-volume and ultra-low volume formulations.

A few common sense rules can make mixing and loading safer, thereby helping you to avoid the leading cause of pesticide-related illnesses:

1. Before handling a pesticide, READ THE LABEL.
2. Based on label recommendations, put on protective clothing and use other necessary protective equipment. Also from reading the label, follow instructions on what special equipment is necessary. If you have questions concerning protective equipment, contact your county agricultural commissioner or other expert before you open the container.
3. Mix the pesticides outdoors, in a place where there is good light and ventilation. If you must mix or load pesticides indoors or at night, make sure you have good ventilation and lighting.
4. Stand upwind of the pesticide to avoid contaminating yourself.
5. Use a sharp knife to open paper bags; do not tear them or the label.
6. Measure accurately; use only the amount you need to apply at the rate specified on the label.
7. When removing the concentrated material from the container, keep the container below your waist if possible to prevent the possibility of splashing or spilling any pesticide into your face and eyes.
8. If you splash or spill a pesticide while mixing or loading, stop immediately! Remove contaminated clothing; and wash thoroughly with detergent and water. Speed is essential if you or your clothing are contaminated. Clean up the spill.

Applying Pesticides

Careful attention to a few simple guidelines during pesticide application will greatly increase your chances of effectively controlling the pest. At the same time, attention to these details will make the job much safer for you, other people, pets, livestock, and the surrounding environment.

1. Before you begin the application, READ THE LABEL. Don't trust your memory for details concerning the use of any pesticide.
2. Check the application equipment. Look for leaking hoses or connections, plugged or worn nozzles, and examine the seals on the filter openings to make sure they will prevent spillage of the chemicals.
3. Calibrate your equipment before use. Make certain that your equipment is adjusted according to the manufacturer's specifications and meets label requirements for the product being applied. This will assure that the proper dosage is being applied to the target site.
4. Before the pesticide application starts, clear all livestock, pets and people from the area to be treated. Although it would be the ideal situation, most ULV labels do not require this. Always check the label for any specific restrictions.
5. Apply the pesticide at the recommended rate. Do not exceed the maximum application rate specified on the label or the written recommendation.
6. Apply pesticides only at the correct time and under acceptable weather conditions – check the label for specific limitations. Avoid applying pesticides when temperatures are extremely high or low. Be especially careful when temperatures exceed 85ºF or are below 50ºF.
7. When handling category I and II toxic pesticides, one should try to not work alone.
8. Use extreme care to prevent the pesticide from contaminating unintended target sites (e.g., streams, ponds, lakes or other bodies of water). Remember also that direct application of pesticides to these types of bodies of water requires special permitting.
9. Avoid situations where the pesticide may drift from the application area and contaminate non-targets.
10. Do not contaminate food or feed through careless application methods.

Equipment Clean-up

After completing the application of any pesticide, immediately clean the mixing, loading, and application equipment. The cleaning operation can be somewhat hazardous if proper precautions are not followed. People who clean the equipment must:

1. Know the correct procedures for cleaning and decontamination.
2. Wear the appropriate personal protective equipment.
3. Know and use the specific area set aside for cleaning. This will usually be on a wash rack or concrete apron that has a well-designed sump to contain all contaminated wash water and pesticides for later disposal, or in the field where rinse water may be considered part of the application.

Pesticide Wastes and Disposal Methods

Waste materials should be considered hazardous to the public, the people handling them and the environment. Deciding how to dispose of pesticide wastes should be done on a case-by-case basis. Materials that meet the legal requirements as hazardous wastes in California (some pesticides, used crankcase oil, used antifreeze, etc.) must be disposed of according to special rules.

Waste materials that are not classified as hazardous waste can be disposed of in other ways, but should never be dumped into drains or water courses of any kind. The best way to avoid all waste pesticides is to use them up in legal pesticide applications. Even the rinse water used in cleaning pesticide equipment can be used as a diluent in tank mixes that contain water soluble pesticides.

Pesticide Container Wastes
Always dispose of pesticide containers in a manner specified on the label. Pesticide container disposal can be a significant problem, particularly if you have a large number of containers. Many pesticide containers can be recycled, either as a part of a regular recycling program, if approved on the label, or by returning to the chemical supplier. Many chemical companies now re-cycle their pesticide containers.

Before disposing of any empty pesticide container, it must be rinsed. The correct rinse procedure follows:
1. Empty the container into the mixing tank and allow the pesticide to drain for an extra 30 seconds. Do not fill the tank to the desired level yet. First complete the triple rinse method described here, adding the rinse solution to the tank as described in (4) below.
2. Add the correct amount of water for thorough rinsing as follows:
   - Size of Container
   - Amount of Rinse Water
   - Less than 5 gallons
   - One-fourth container volume
   - 5 gallons or more
   - One-fifth container volume

3. Replace the container closure; then rotate and shake the container, so that the rinse reaches all interior surfaces.
4. Drain the rinse solution from the container into the mixing tank. Allow the container to drain for an extra 30 seconds after emptying.
5. Repeat this rinsing procedure at least two more times for a total of three rinses. Remember—it is important to empty each rinse into the mixing tank so that the pesticide goes on the target for which it is intended (this procedure also saves money). Never pour pesticides down an ordinary drain or flush them down a toilet!
6. Now the triple rinse procedure is complete. Let the container dry and replace the cover.

Many containers will be discarded after one use. California regulations concerning pesticide container disposal do not apply to containers in which household pesticides have been packaged. However, these containers (except aerosol cans) should be rinsed carefully and destroyed to prevent their reuse.

Unused and Excess Pesticide Disposal
Disposing of unused (still in the original container) and excess (already mixed, but not needed) pesticides can be a significant problem. For vector control agencies, the easiest solution is to mix only as much product as will be needed. This is critical for Bacillus thuringiensis var. israelensis (Bti) because it looses efficacy after 24 hours.

The best way to dispose of any currently labeled pesticide is to apply it according to the label. If that is not possible because of a label change, contact your local County Agricultural Commissioner – in many instances, you will be directed to use the remainder of the product per label instructions. For any currently labeled pesticide, the best alternative would be to find another person or area with the same pest problem, so that the pesticide gets used up legally and effectively.

If you cannot find another area with the same problem, you might decide to dispose of the pesticide in an approved location. Contact the California Department of Pesticide Regulation, or your County Agricultural Commissioner for specific information on regulations and pesticide dump sites.

Personal Clean-up

After you have completed the pesticide application, disposed of excess material, and cleaned the application equipment, you should thoroughly wash all your protective equipment. Remove your work clothes and place them in an area separate from other laundry items or properly dispose of them if they are disposable coverall, e.g., Tyvek®. Do not allow children to play in or with the contaminated clothing.

The pesticides on your work clothes could contaminate people who touch them, so warn whoever will be washing the clothes of the possible danger, and tell this person that pesticide-contaminated clothing should be washed separately from other clothing. Now take a shower. Wash yourself completely with soap and water. Remember to include your hair and fingernails in the wash-up. Do not put on any article of clothing worn while working with pesticides until after it has been laundered.

Pesticide Spills

Since some pesticides qualify as hazardous materials, a variety of local, county, and state agencies will become involved in reporting and cleanup, especially if the spill occurs while pesticides are in transit. In this case, peace officers are often the first responders, and they are required to report pesticide spills under the California Vehicle Code.

Pesticide spills that cannot easily be cleaned-up and decontaminated by vector control program personnel can be reported directly to the local health officer who will in turn contact the County Agricultural Commissioner or the County Health and/or Environmental Health Department. One should also use common sense judgment to determine the danger that is created with a spill, e.g., a spill that occurs in a confined and enclosed area versus an open area.

In spite of the most careful use and handling of pesticides, accidental spills and fires occasionally occur. These range in size from small spills of a household pesticide container to huge fires involving entire manufacturing warehouses filled with the most toxic pesticides. Intelligent planning, knowledge of the chemicals involved and calm consideration of the actual hazards to be dealt with during the emergency will reduce the risk and damage resulting from the accident.

Pesticide spills can and do happen anywhere pesticides are transported, stored, or applied. When a spill occurs, it should be cleaned up as quickly and safely as possible.

For some pesticides and formulations, such as Altosid® pellets, clean-up is as simple as collecting the spilled product and using it. A few general rules apply to all pesticide spill clean-ups.

1. Avoid exposure of people and animals to the pesticide. If you spill a pesticide, immediately see to it that no one is exposed or contaminated by accidentally walking into the spill or breathing the fumes.
2. Start by putting on protective clothing so that you do not contaminate yourself.
3. Provide some sort of a barrier to the spread of a liquid pesticide. A barrier may be made of dirt, sawdust, old newspapers or anything that will soak up the pesticide.
4. Remove the contaminated materials to a safe place. If the spill is inside the home or another building, soak up liquid pesticides or sweep up powders and remove them to the outside. Ventilate the area to prevent the buildup of toxic fumes.
5. Thoroughly clean the affected surface. Consult the label for specific disposal and decontamination instructions. Take care to prevent the wash from spreading and possibly contaminating a larger area. Make sure any wash does not go into storm drains or sewer systems.
6. If the spill that cannot be easily cleaned involves a public area, such as a highway, notify the police, sheriff's office, fire department, the highway patrol, or other local emergency services agency.
7. While waiting for emergency personnel to arrive, do what you can to prevent others from being exposed to the pesticide.

Remember: The highest priorities are to prevent exposure to the pesticide and to prevent the spread of the spill. In the event of a large spill that cannot be easily contained, contact emergency services personnel, tell them about the nature of the chemical and explain to them what you know about the pesticide involved. If it is a Toxicity Category I or II pesticide, their lives may depend on your warning!

Pesticide Fires

Small Fires
If a fire occurs in an area where pesticides are used or stored, and the fire is very small and easily extinguished, you may elect to attack it yourself if you follow certain precautions:
1. Use foam or carbon dioxide from a fire extinguisher in lieu of water if at all possible.
2. Wear protective safety equipment.
3. Avoid exposure of smoke, mist, spray, runoff, and concentrated pesticide chemicals.

Large Fires
In the event of any large fire, contact emergency fire services immediately! When large fires involving the presence of very toxic materials (including pesticides) occurs, the fire department responding to the emergency call will seek the aid of specialized agencies which deal with such chemical emergencies.

Whenever pesticides are involved in fires, they can create special hazards. Anyone in the vicinity of the fire may be exposed to toxic fumes, poisonous runoff, and concentrated pesticides from leaking or exploding storage containers. Here are some general rules that apply to pesticide fires.

Maintaining communications with the responding fire department is essential. Keep them updated on what chemicals you are storing, where it is stored, how much is being stored, and supply them with any information such as material safety data sheets they may request concerning the nature of the chemicals. This may allow them to prepare for possible emergencies and may save lives and property.

Before the fire department arrives you should:
1. Not risk your own health to fight a large fire — consider the risks of potentially toxic smoke, explosion, and your limited capacity to control the fire. You may inadvertently risk the health and safety of the professionals or others, particularly if you are injured in your attempts. Do not attempt to fight the fire unless you have been trained to do so; it is the job of highly trained professionals to fight fires.
2. Avoid poisoning: Keep yourself and others out of smoke, mist, spray, and pesticide runoff.
3. Notify all those in close proximity of the fire and downwind and tell them to evacuate the area.
4. Wear personal protective equipment if it can be safely retrieved.

After the arrival of the fire department, you should:
1. Without risking your health or safety, take steps to minimize contamination of areas outside the fire zone by runoff from fire fighting. This can help contain spilled pesticide and thus avoid affecting people and domestic animals and the environment. It is especially important to avoid runoff of contaminated water into nearby streams or lakes.
2. Cool nearby pesticide containers; move vehicles and any threatened mobile equipment if it is safe to do so.

Adverse Pesticide Related Events
For vector control agencies, adverse pesticide related events must be reported to the California Department of Public Health and the County Agricultural Commissioner.
Adverse events (conspicuous or suspected) that must be reported:
1. Any human illness associated with a vector control pesticide application.

2. Any report of harmful non-target effects of an application to plants, domestic animals, or wildlife.
3. Any pesticide spill requiring an emergency services response.

Sprayer Cleanout Fact Sheet

Key Points:

- Proper cleaning and maintenance of spray equipment are essential parts of effective pest control.

- Sulfonylurea herbicides are no more difficult to remove from application equipment than any other herbicide. As with any herbicide, if a highly sensitive crop is going to be sprayed, it is important to use thoroughly cleaned equipment. When a crop is highly sensitive to any herbicide, even a very low level of carry-over can cause damage.

- Many factors can influence the effectiveness of sprayer cleaning procedures, including design and maintenance of the equipment, residues from previous applications, and the presence of tank mix partners (including additives).

Because residues from previous applications can trap subsequent compounds and make it more difficult to clean them from the system, it is important to start with clean equipment. Equipment should be rinsed immediately after spraying, using cleaning procedures specified on the label as soon as possible after rinsing so that compounds will not dry onto the surface of tanks and hoses.

The product label also notes approved product combinations. Incompatibility between products can result in deposits that are difficult to clean from equipment. For approved product combinations, it is important to add the products in the recommended order. Adding products in the wrong order can also result in deposits that are difficult to remove.

Even when the sprayer is operated until visibly empty, small amounts of spray solution can remain in the equipment. When the same equipment is used to spray different crops during the season, injury to sensitive crops may result if traces of previous products remain in the sprayer. The sensitivity of various crops to injury by different products is highly dependent on the specific product, the rate at which it is applied, the ability of the vegetation to break down the product, and the growth stage of the vegetation.

Cleanup procedures work through three primary mechanisms: dilution, deactivation, and extraction. All procedures use dilution, which lowers the concentration of the crop protection product by repeated addition and drainage of fresh cleaning solution.

Deactivation occurs when the cleaning solution causes the crop protection product to decompose into compounds that are no longer active for their intended use. Extraction occurs when the cleaning solution causes chemical deposits that can accumulate in application equipment to loosen or dissolve.

Older, poorly maintained spraying equipment with rusted, pitted components can trap crop protection products, making them difficult to remove. Multiple applications of a product over a period of time without interim rinsing can lead to a buildup of deposits.
Certain tank mixes can hinder cleanup by forming deposits and trapping products on equipment surfaces. If the sprayer is not clean prior to using, deposits from a previously used product can also trap subsequent products and ultimately reduce their exposure to the cleaning agent. These deposits can break free during subsequent applications.

When proper cleanup procedures are not followed, crop protection products left in the spray system can damage sensitive crops in a future application. Adequate cleanup procedures should be followed, according to the product label. Dupont works with sprayer manufacturers to design equipment that can be efficiently cleaned. Dupont also conducts research on improving cleanout procedures and on evaluating the effectiveness of cleaning agents.

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.

Pesticide Application Record Example

Farm:	Fertilization:
Field/Site:	Date Harvested:
Soil Type:	Yield:
Crop Last Year:	Notes:

The first eight items are required to be kept for two years by United States Department of Agriculture for all restricted use pesticide applications under the Food Agriculture Conservation and Trade (FACT) Act of 1990.

1. NAME AND CERTIFICATION NUMBER OF APPLICATOR:

MAKE A RECORD OF EACH APPLICATION OF EACH PESTICIDE					
1. Name	App. # 1	App. # 2	App # 3	App. # 4	App. # 5
2. Field or Site Location/ID					
3. Date (Mo., Day, Year)					
4. Size of Area Treated					
5. Pesticide Used (Brand Name)					
6. EPA Registration Number					
7. Total Amount Applied					
8. Crop/Commodity or Site					
9. Formulation					
10. Additives					
11. Method of Application					
12. Stage of Crop Growth					
13. Purpose of Application					
14. Stage of Development of Pest					
15. Soil Conditions					
16. Temperature					
17. Time of Day					
18. Wind					
19. Cloud Cover					
20. Effectiveness					

Instructions

This form can be used for recording pesticide applications for weed, insect, or disease control to a particular field or part of a field during a growing season. Farmers may find the record useful for evaluating results and planning future chemical treatments.

The United States Department of Agriculture now requires all applicators of Restricted Use Pesticides (RUP) to record certain information within 14 days of every RUP application. These records are required to be kept for two full years. An "*" is placed next to the USDA required RUP information.

1. *Name and certification number of applicator.
2. *Field or Site Location/ID—give name or location of the field or site (or the part of field) treated. See map section below.
3. *Date—fill in the month, day, and year of the application.
4. *Area treated—in acres, square feet, etc. If banding pesticides give total size of the field, not just the area actually treated in the band.
5. *Pesticide used—give product, trade, or brand name. Listing common names of active ingredients in the product is also often helpful.
6. *EPA registration number—from the pesticide label.
7. *Total amount applied—list total amount of formulated product (pounds, ounces, quarts, gallons, etc.) used on the total area treated given in 3 above.
8. *Crop or site—give the crop, commodity, stored product or site to which the pesticide was applied.
9. Formulation—use liquid (L), emulsifiable concentrate (EC), wettable powder (WP), granules (G), dust (D), soluble powder (SP), dry flowables (DF), or pellets (P).Additives—indicate type and amount of any additives such as oils, spreaders, stickers, surfactants, wetting agents, detergents, or other adjuvants.
10. Method of application—broadcast, band, pre-plant, pre-emergence, post-emergence, directed, aerial, airblast, and method of incorporation (if any), and implement used.
11. Stage of crop growth—use height in inches, number of leaves or other generally used description (tasseling, flowering, heading, etc.).
12. Purpose of application—give specific names of target weeds, insects, diseases, or other reason.
13. Stage of development of pest—for weeds, diseases and insects. List height of weeds, number of leaves; adult, larva, or nymph stage of insect; degree of infestation or percentage of plants infected.

14. Soil conditions—at time of treatment.

15. Temperature—self-explanatory.

16. Time of day—self-explanatory.

17. Wind—self-explanatory.

18. Cloud cover—self-explanatory.

19. Effectiveness—indicate good, fair, or poor. It is advisable to sometimes leave untreated check strips.

Follow the Keys to Pesticide Safety

READ THE LABEL ON EACH PESTICIDE CONTAINER BEFORE EACH USE. Follow all instructions, heed all precautions, and use protective clothing and equipment as required.

APPLY PESTICIDES ONLY AS DIRECTED. Follow label directions for time, rate, method and crop or site of application.

RINSE PESTICIDE CONTAINERS AT THE TIME OF USE. Follow required triple-rinse or pressure-rinse procedures.

STORE PESTICIDES IN THEIR ORIGINAL, LABELED CONTAINERS. Keep them out of the reach of children and irresponsible people.

Field or site Location and ID

NORTH	

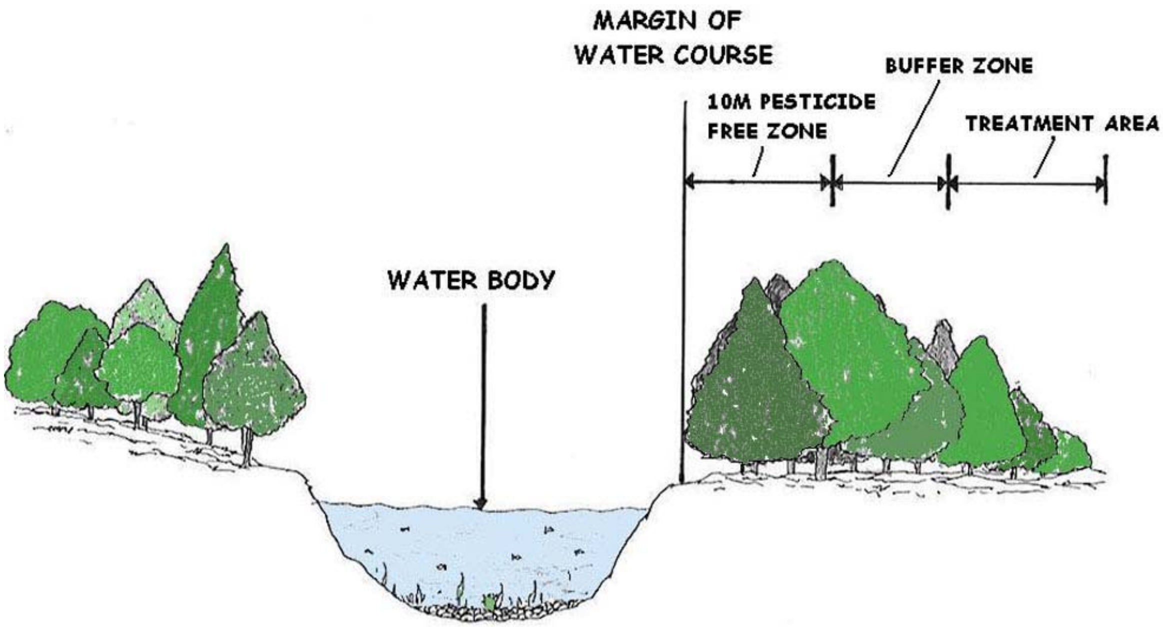
Master List

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.

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.

Knowledge of Labeling Information

A handler employer 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).

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.

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:

"Agricultural Requirements"
Sadly many applicators, handlers and Workers lack or ignore this section and all of these have a huge chance of pesticide poisoning. I know many who become used to tasting and touching chemicals without protection. Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment, notification of workers, and restricted-entry intervals."

If you are using a pesticide product with labeling that refers to the Worker Protection Standard, you must comply with the WPS. Otherwise, you will be in violation of federal law, since it is illegal to use a pesticide product in a manner inconsistent with its labeling.

Which Pesticide Uses are not covered?

Some pesticide uses are not covered by the WPS, even when the "Agricultural Use Requirements" section is on the labeling. For example, if the pesticide labeling bears an "Agricultural Use Requirements" section, but the product also can be applied to rights-of-way, the rights-of-way use is not covered by the WPS. The WPS does ***not*** cover pesticides applied:

- on pastures or rangelands,
- for control of vertebrate pests such as rodents,
- as attractants or repellents in traps,
- on the portions of agricultural plants that have been harvested, such as in *WPS* packing houses or on cut timber,
- for mosquito abatement, Mediterranean fruit fly eradication, or similar government-sponsored wide-area public pest control programs,
- on livestock or other animals, or in or around 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, golf courses, and public or private lawns and grounds and that are intended only for decorative or environmental benefit,
- in a manner not directly related to the production of agricultural plants, including, for example, control of vegetation along rights of way and in other non-crop areas and structural pest control, such as termite control and wood preservation,
- for research uses of unregistered pesticides.

The WPS does not cover **workers** who are working in an area where a pesticide has been injected directly into the plants. However, people who **handle** pesticides that are to be *Direct* *injection does not* applied by direct injection ***are*** covered by the WPS and must receive handler protections.

Compensation *includes pay or wages, payment through services or goods, or barter of services or goods. If only one person receives payment for the joint work of several people, all are considered to be compensated, and are employees under the WPS.*

For example, under a piece-rate payment system for harvesting crops, even if payment is issued to the head of the family only, all of the family members who harvest crops are considered employees under the WPS.

Integrated Pest Management

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.

Who Must Protect Workers and Handlers?

Employers are responsible for making sure that workers and handlers receive the protections required by the pesticide labeling and the WPS. The term “employer” has a special meaning in the WPS — you are an employer even though you are self-employed or use only members of your own family to do the work on your establishment.

The WPS has very specific definitions for two types of employers. WPS requirements apply only to employers who meet those definitions.

WPS EMPLOYER DEFINITIONS
Worker Employers:
Worker employers are people who:
• **employ or contract for the services of workers** (including themselves and members of their family) for any type of compensation to perform tasks related to the production of agricultural plants, or
•**own or operate** an agricultural establishment that uses such workers. (See definition of “owner,”.) (See definition of “worker,”.)

If you are a worker employer, you are responsible for providing your agricultural worker employees with the protections that the WPS requires for **workers**. (In the WPS itself, “worker employers” are called “agricultural employers.”)

Handler Employers:
Handler employers are people who:
• **employ pesticide handlers** (including members of their family), for any type of compensation, or
• **are self-employed as pesticide handlers**. (See definition of “pesticide handler,”.)

If you are a handler employer, you are responsible for providing the pesticide handlers you employ with the protections that the WPS requires for **handlers**.

If You Employ Supervisors
You must:
• require them to make sure the workers and handlers they supervise comply with the WPS and receive its protections,
• give them enough information and directions about the WPS requirements to make sure that the workers and handlers they supervise receive the protections required by the WPS, and
• tell them who is responsible for all actions necessary for compliance with the WPS. Even if you assign an employee to carry out the duties required by the WPS, **you are responsible** for making sure that all those duties are performed.

Retaliation Prohibited
You and your supervisors must not prevent or discourage any worker or handler from complying or attempting to comply with the WPS, and you must not fire or otherwise retaliate against any worker or handler who attempts to comply.

Penalties for Noncompliance
Agricultural and handler employers can be subject to civil and criminal penalties if found not complying with the federal Worker Protection Standard including all revisions through 2004. Failure to comply is a pesticide misuse violation — also known as use of a pesticide in a manner inconsistent with its labeling. Failure to comply with distinct acts of the WPS may result in independently assessable charges, even if the violative acts occurred during one pesticide application.

Currently, a federal civil penalty of up to $1,100 per violation may be assessed against private applicators (owners/operators of agricultural establishments) and other persons, and up to $6,500 per violation against commercial applicators (owners/operators of pesticide handling establishments) and other persons. Since Congress passed the Civil Monetary Penalty Inflation Adjustment Rule under the Debt Collection Improvement Act of 1996, civil penalties have been increased due to inflation and Congress' intent on creating a deterrence to noncompliance. The next civil penalty adjustment is expected to occur in 2009.

Criminal penalties can also be assessed if the WPS is knowingly violated. Federal fines include up to $1,000 per offense and 30 days in jail for private applicators, and up to $25,000 and 1 year in jail for commercial applicators.

Labeling Overrides WPS
If the pesticide product labeling contains specific instructions or requirements that conflict with the requirements of the Worker Protection Standard, **follow the instructions or requirements on the labeling**. For example, some pesticide labeling may:

- prohibit any early-entry activity, including short-term and emergency tasks,
- allow an early-entry activity that the WPS does not allow,
- require the use of personal protective equipment even if closed systems are used for mixing and loading.

Exceptions to Labeling Statements
The WPS allows certain exceptions to three specific pesticide labeling requirements: **personal protective equipment** , **restricted-entry intervals**, and **double notification** (the requirement on some labeling for both oral warnings **and** posting treated areas). The WPS statements in the Agricultural Use Requirements box on the product labeling will tell you that the WPS contains these exceptions.

Most states and tribes enforce under their own laws and regulations and have their own penalties, which may differ from federal penalties. Pesticide-related ordinances and associated penalties may also be imposed by local governments.

Respiratory Protection 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

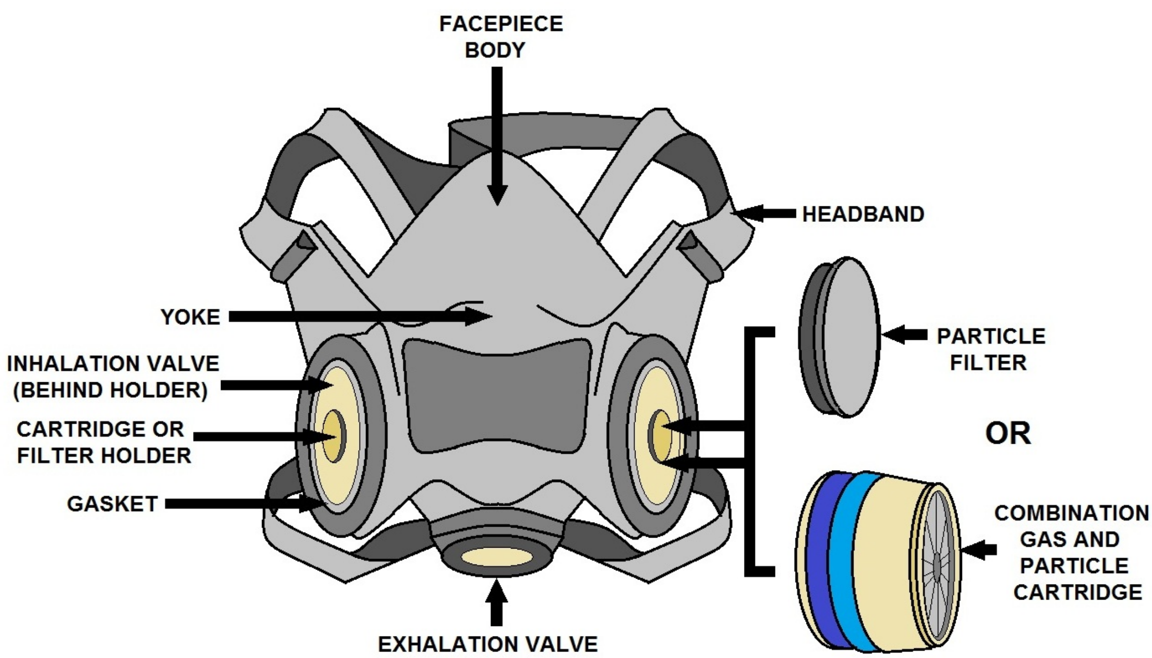
Selection of Respiratory Protection
When choosing the correct respiratory protection for your work environment, it is important to consider:

- Identification of the substance or substances for which respiratory protection is necessary
- A substance's material safety data sheet (**MSDS**) (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.



BASIC PARTS OF A HALF-FACEPIECE RESPIRATOR

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.

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.

Contractor Employees

Process safety training and safety programs are also required for contractors who work on-site. Managers must check out the safety performance and programs of any contractors being considered for maintenance, repair, turnaround, major renovation, or specialty work on or around a process covered by the regulation.

When a contractor is hired, the manager must provide the contractor with information on the hazards of the process the contractor will work on. To further ensure contractor safety, managers must also:
- Provide the contractor with information on safe work practices for the process they're involved with and tell them what to do in an emergency.
- Keep a log of contractor employees' injuries or illnesses related to their work in process areas.
- Evaluate the contractor's performance to make sure they're living up to their safety obligations under the standard.

The contractor has responsibilities, too.
- Document that employees are trained to recognize hazards and to follow safe work practices on the job.
- Make sure that the contractor's employees understand potential job-related hazards, are trained to work safely, and follow the safety rules of the facility in which they're working.

More on the Respiratory Protection Program

This paragraph requires the employer to develop and implement a written respiratory protection program with required worksite-specific procedures and elements for required respirator use. The program must be administered by a suitably trained program administrator. In addition, certain program elements may be required for voluntary use to prevent potential hazards associated with the use of the respirator.

The Small Entity Compliance Guide contains criteria for the selection of a program administrator and a sample program that meets the requirements of this paragraph. Copies of the Small Entity Compliance Guide is available from the Occupational Safety and Health Administration's Office of Publications, Room N 3101, 200 Constitution Avenue, NW, Washington, DC, 20210 (202-219-4667).

(c)(1) In any workplace where respirators are necessary to protect the health of the employee or whenever respirators are required by the employer, the employer shall establish and implement a written respiratory protection program with worksite-specific procedures. The program shall be updated as necessary to reflect those changes in workplace conditions that affect respirator use. The employer shall include in the program the following provisions of this section, as applicable:

(c)(1)(i) Procedures for selecting respirators for use in the workplace;

(c)(1)(ii) Medical evaluations of employees required to use respirators;

(c)(1)(iii) Fit testing procedures for tight-fitting respirators;

(c)(1)(iv) Procedures for proper use of respirators in routine and reasonably foreseeable emergency situations;

(c)(1)(v) Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators;

(c)(1)(vi) Procedures to ensure adequate air quality, quantity, and flow of breathing air for atmosphere-supplying respirators;

(c)(1)(vii) Training of employees in the respiratory hazards to which they are potentially exposed during routine and emergency situations;

Example of Responsibilities
All Employees shall follow the requirements of the Respiratory Protection Program.

Management
- implement the requirements of this program
- provide a selection of respirators as required
- enforce all provisions of this program
- appoint a *Specific Designated* individual to conduct the respiratory protection program

Administrative Department
- Review sanitation/storage procedures.
- ensure respirators are properly, stored, inspected and maintained.
- monitor compliance for this program.
- provide training for affected Employees.
- review compliance and ensure monthly inspection of all respirators.
- provide respirator fit testing.

Designated Occupational Health Care Provider
- conducts medical aspects of program.

Program Administrator
Each Department will designate a program administrator who is qualified by appropriate training or experience that is commensurate with the complexity of the program to administer or oversee the respiratory protection program and conduct the required evaluations of program effectiveness.

Voluntary Use of Respirators is Prohibited
OSHA requires that voluntary use of respirators, when not required by the Employer, must be controlled as strictly as under required circumstances. To prevent violations of the Respiratory Protection Standard, Employees are not allowed voluntary use of their own or Employer supplied respirators of any type.

Exception: Employees whose only use of respirators involves the voluntary use of filtering (non-sealing) face pieces (dust masks).

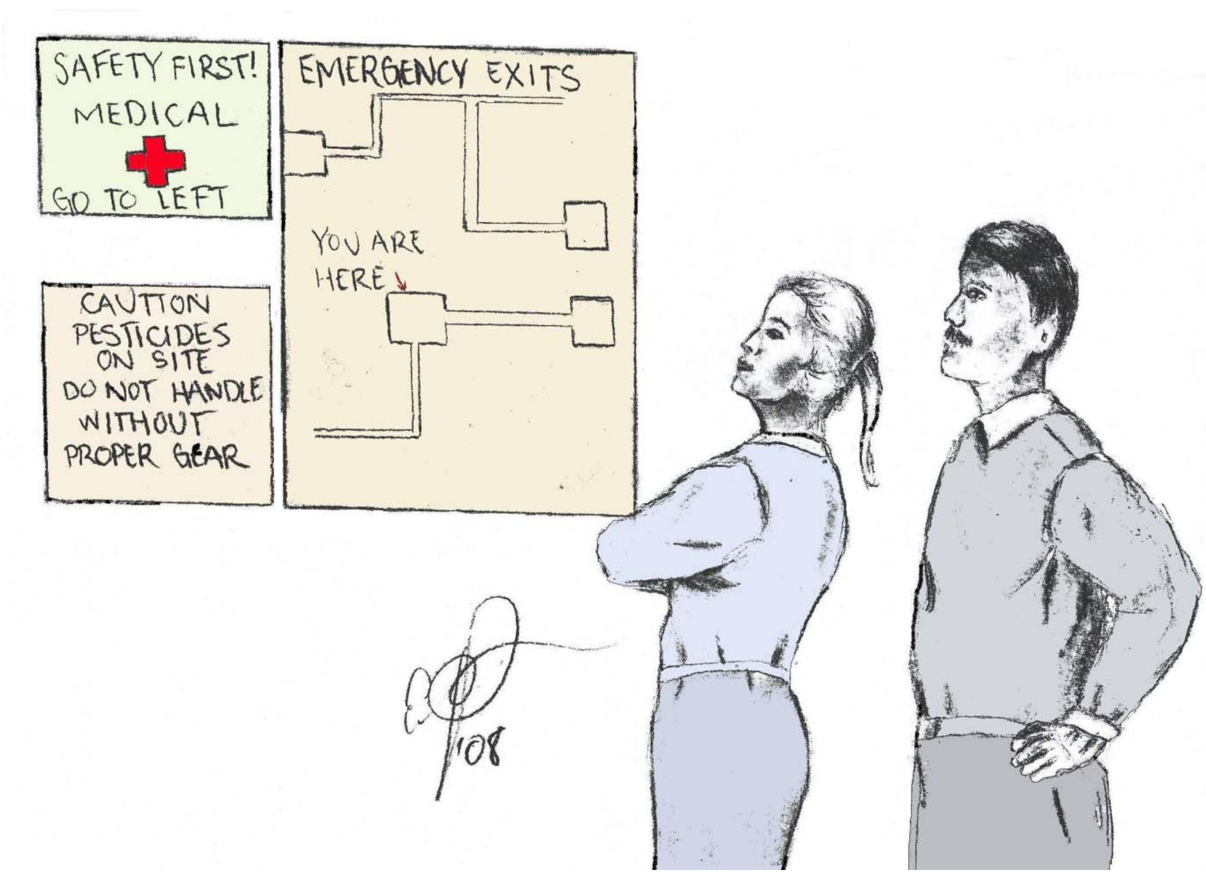
Program Evaluation

Evaluations of the workplace are necessary to ensure that the written respiratory protection program is being properly implemented; this includes consulting with employees to ensure that they are using the respirators properly. Evaluations shall be conducted as necessary to ensure that the provisions of the current written program are being effectively implemented and that it continues to be effective.

Program evaluation will include discussions with employees required to use respirators to assess the employees' views on program effectiveness and to identify any problems.

Any problems that are identified during this assessment shall be corrected. Factors to be assessed include, but are not limited to:

- Respirator fit (including the ability to use the respirator without interfering with effective workplace performance);
- Appropriate respirator selection for the hazards to which the employee is exposed;
- Proper respirator use under the workplace conditions the employee encounters; and
- Proper respirator maintenance.



Recordkeeping
The Employer will retain written information regarding medical evaluations, fit testing, and the respirator program.

This information will facilitate employee involvement in the respirator program, assist the Employer in auditing the adequacy of the program, and provide a record for compliance determinations by OSHA.

Training and Information
Effective training for employees who are required to use respirators is essential. The training must be comprehensive, understandable, and recur annually and more often if necessary. Training will be provided prior to requiring the employee to use a respirator in the workplace.

The training shall ensure that each employee can demonstrate knowledge of at least the following:

- Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator
- Limitations and capabilities of the respirator
- How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions
- How to inspect, put on and remove, use, and check the seals of the respirator
- What the procedures are for maintenance and storage of the respirator
- How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators
- The general requirements of this program

Retraining shall be conducted annually and when:

- changes in the workplace or the type of respirator render previous training obsolete
- inadequacies in the employee's knowledge or use of the respirator indicate that the employee has not retained the requisite understanding or skill
- other situations arise in which retraining appears necessary to ensure safe respirator use

Training is divided into the following sections:

Classroom Instruction
1. Overview of the Employer’s Respiratory Protection Program & OSHA Standard
2. Respiratory Protection Safety Procedures
3. Respirator Selection
4. Respirator Operation and Use
5. Why the respirator is necessary
6. How improper fit, usage, or maintenance can compromise the protective effect.
7. Limitations and capabilities of the respirator.
8. How to use the respirator effectively in emergency situations, including respirator malfunctions
9. How to inspect, put on and remove, use, and check the seals of the respirator.
10. What the procedures are for maintenance and storage of the respirator.
11. How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators.

12. Change out schedule and procedure for air purifying respirators.

Fit Testing - Hands-on Respirator Training (see appendix A for more information)
1. Respirator Inspection
2. Respirator cleaning and sanitizing
3. Record Keeping
4. Respirator Storage
5. Respirator Fit Check
6. Emergencies

Basic Respiratory Protection Safety Procedures

1. Only authorized and trained Employees may use Respirators. Those Employees may use only the Respirator that they have been trained on and properly fitted to use.
2. Only Physically Qualified Employees may be trained and authorized to use Respirators. A pre-authorization and annual certification by a qualified physician will be required and maintained. Any changes in an Employees health or physical characteristics will be reported to the Occupational Health Department and will be evaluated by a qualified physician.
3. Only the proper prescribed respirator or SCBA may be used for the job or work environment. Air cleansing respirators may be worn in work environments when oxygen levels are between 19.5 percent to 23.5 percent and when the appropriate air cleansing canister, as determined by the Manufacturer and approved by NIOSH or MESA, for the known hazardous substance is used. SCBAs will be worn in oxygen deficient and oxygen rich environments (below 19.5 percent or above 23.5 percent oxygen).
4. Employees working in environments where a sudden release of a hazardous substance is likely will wear an appropriate respirator for that hazardous substance (example: Employees working in an ammonia compressor room will have an ammonia APR respirator on their person.).
5. Only SCBAs will be used in oxygen deficient environments, environments with an unknown hazardous substance or unknown quantity of a known hazardous substance or any environment that is determined *"Immediately Dangerous to Life or Health"* (IDLH).
6. Employees with respirators loaned on "permanent check out" will be responsible for the sanitation, proper storage and security. Respirators damaged by normal wear will be repaired or replaced by the Employer when returned.
7. The last Employee using a respirator and/or SCBA that are available for general use will be responsible for proper storage and sanitation. Monthly and after each use, all respirators will be inspected with documentation to assure its availability for use.
8. All respirators will be located in a clean, convenient and sanitary location.
9. In the event that Employees must enter a confined space, work in environments with hazardous substances that would be dangerous to life or health should an RPE fail (a SCBA is required in this environment), and/or conduct a HAZMAT entry, a "*buddy system*" detail will be used with a Safety Watchman with constant voice, visual or signal line communication. Employees will follow the established Emergency Response Program and/or Confined Space Entry Program when applicable.
10. Management will establish and maintain surveillance of jobs and work place conditions and degree of Employee exposure or stress to maintain the proper procedures and to provide the necessary RPE.
11. Management will establish and maintain safe operation procedures for the safe use of RPE with strict enforcement and disciplinary action for failure to follow all general and specific safety rules.

Pesticide Application Post Quiz

Identify the missing term or word

1. Nozzle spacing and the boom distance from the target are important in both horizontal and vertical booms to achieve___________.

2. The main advantage of __________is that it can be carried out quickly and at times when ground equipment cannot operate.

3. ___________ 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.

4. _______________ is not approved for use in indoor residences.

5. The mechanism of action of ____________ involves inhibiting the production of chitin which is used by an insect to build its exoskeleton.

6. ____________ is a juvenile hormone analogue, preventing larvae from developing into adulthood and thus rendering them unable to reproduce.

7. ______________ takes advantage of all appropriate pest management options including, but not limited to, the judicious use of pesticides.

8. This term means 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).

9. __________________ includes the introduction of naturally occurring predators at either an inundative or inoculative level.

10. Examples of _____________ include Arborchem and kerosene.

Answers

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

Agricultural Pesticide Application Section

USING A BACKPACK SPRAYER

New and Required EPA Information

All agricultural employers whose workers perform hand labor operations in fields, forests, nurseries, and greenhouses treated with pesticides, and handle pesticides in these locations are covered by the U.S. Environmental Protection Agency's worker protection standard revised 2015.

Agricultural employers must be in full compliance with this regulation before January 1, 2017 but the rule will start into effect starting 2016. Additionally, owners, operators, and their immediate family members must comply with some of the provisions of this standard.

Agricultural employers must be in full compliance with the U.S. Environmental Protection Agency's (**EPA**) 2015 worker protection standard.

Precise estimates of the number of workers and handlers who will be covered by the WPS are unknown, but the EPA estimates that nearly 5 million owners, operators, family members, hired workers and handlers could be affected.

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

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). Although it is now technically active it will not be enforced until 2017 but the original WPS will still be enforced until the end of 2016. Please keep in mind that the WPS covers both restricted use AND general use pesticides. This course will deal with the highlights to the revision but also some areas of the current WPS that need emphasized.

The Environmental Protection Agency has revised the 1992 Agricultural Worker Protection Standard regulation to increase protection from pesticide exposure for the nation's two million agricultural workers and their families.

These changes will afford farmworkers similar health protections that are already afforded to workers in other industries while taking into account the unique working environment of many agricultural jobs.

The regulation seeks to protect and reduce the risks of injury or illness resulting from ***agricultural workers'*** (those who perform hand-labor tasks in pesticide-treated crops, such as harvesting, thinning, pruning) and ***pesticide handlers'*** (those who mix, load and apply pesticides) use and contact with pesticides on farms, forests, nurseries and greenhouses. The regulation does not cover persons working with livestock.

Employers covered by the WPS must:
Reduce overall exposure to pesticides by prohibiting handlers from exposing workers during pesticide application, excluding workers from areas being treated and areas under a restricted entry interval, and notifying workers about treated areas. Some activities are allowed during restricted entry intervals if workers are properly trained and protected.

Mitigate exposures by requiring decontamination supplies be present and emergency assistance be available. Inform workers about pesticide hazards by requiring safety training (workers and handlers), safety posters, access to labeling information, and access to specific information (listing of treated areas on the establishment).

WPS provisions are very complicated and are likely to affect a large number of employers and their workers.

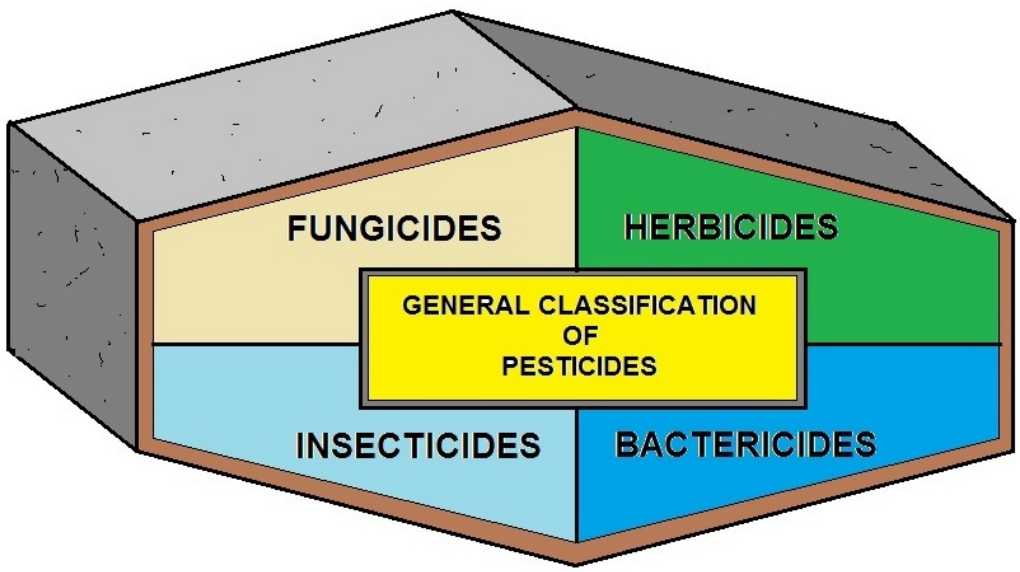
States may also issue worker protection standards that are stricter than the WPS. Therefore, employers should contact their State agency that regulates the Federal Insecticide, Fungicide, and Rodenticide Act in cooperation with the EPA to determine whether they must comply with the WPS and local regulations. Nothing in this report replaces technical and professional legal advice.

Background
The Federal Insecticide, Fungicide, and Rodenticide Act (**FIFRA**) of 1947, as amended, sets an overall risk/benefit standard for pesticide registration, requiring that all pesticides perform their intended function, when used according to labeling directions, without imposing unreasonable risks of adverse effects on human health or the environment.

During the congressional discussion of FIFRA amendments in 1972, the Senate Committee on Agriculture and Forestry (Committee) "*found protection of man and the environment to be a broad term encompassing farmers, farmworkers, and others who come into contact with pesticides...*" (57 FR 38102).

The Committee further found "that the bill [The Federal Environmental Pesticide Control Act of 1972 (FEPCA)] requires the Administrator to require that the labeling and classification of pesticides be such as to protect farmers, farmworkers, and others coming in contact with pesticides or pesticide residues" (57 FR 38102).

Given the above mandate, the EPA issued regulations in 1974 dealing with pesticide-related occupational safety and health of workers performing hand labor operations in fields during and after application of pesticides (40 CFR).



CLASSIFICATION OF PESTICIDES

Agricultural Employers Responsibility

We will go in to great detail on this rule and its requirement.

New WPS Requirements 2015-2018

• Annual mandatory training to inform farmworkers on the required protections. This increases the likelihood that protections will be followed.
• Expanded training includes instructions to reduce take-home exposure from pesticides on work clothing and other safety topics.
• First-time ever minimum age requirement: Children under 18 are prohibited from handling pesticides.
• Expanded mandatory posting of no-entry signs for the most hazardous pesticides. The signs prohibit entry into pesticide-treated fields until residues decline to a safe level.
• New no-entry application-exclusion zones up to 100 feet surrounding pesticide application equipment will protect workers and others from exposure to pesticide overspray.
• Requirement to provide more than one way for farmworkers and their representatives to gain access to pesticide application information and safety data sheets – centrally-posted, or by requesting records.
• Mandatory record-keeping to improve states' ability to follow up on pesticide violations and enforce compliance. Records of application-specific pesticide information, as well as farmworker training, must be kept for two years.
• Anti-retaliation provisions are comparable to Department of Labor's (DOL's).
• Changes in personal protective equipment will be consistent with the DOL's Occupational Safety & Health Administration standards for ensuring respirators are effective, including fit test, medical evaluation and training.
• Specific amounts of water to be used for routine washing, emergency eye flushing and other decontamination, including eye wash systems for handlers at pesticide mixing/loading sites.
• Continue the exemption for farm owners and their immediate family with an expanded definition of immediate family.

What Will These Changes Achieve?
There is a clear need for better protection for farmworkers. Each year, between 1,800 and 3,000 occupational incidents involving pesticide exposure are reported from the farms, forests, nurseries and greenhouses covered by the Worker Protection Standard. There is widespread underreporting.

By better protecting our agricultural workers, the agency anticipates fewer pesticide exposure incidents among farmworkers and their family members. Fewer incidents mean a healthier workforce and avoiding lost wages, medical bills, and absences from work and school. In addition, EPA is concerned about low level, repeated exposure to pesticides that may contribute to chronic illness.

What Types of Activities Are Covered?
The regulation seeks to protect and reduce the risks of injury or illness resulting from agricultural workers' (those who perform hand-labor tasks in pesticide-treated crops, such as harvesting, thinning, pruning) and pesticide handlers' (those who mix, load and apply pesticides) use and contact with pesticides on farms, forests, nurseries and greenhouses. The regulation does not cover persons working with livestock.

Family Exemption
There is an “immediate family” exemption to the WPS that exempts family members from MOST of the WPS protections. However, family members must still use label required PPE (personal protection equipment) and still must obey the REIs (Restricted Entry Intervals) and the other label requirements.

So who falls under the Family Exemption?
The regulation revision has expanded the family exemption to now include first cousins, nephews, nieces, aunts, uncles, grandchildren, grandparents and in-laws. The original exemptions are still valid and they include children, step children, foster children, parents, step parents, foster parents, siblings and spouses and of course the owner. In spite of this exemption why not give your family the benefit of these WPS protections?

Training Changes
This is the area with the most changes. Under the revision growers subject to the WPS must now train their employees every year and they must be trained on Day 1 before they do any work in the crop areas if it has been less than 30 days since the last restricted entry interval expired.

Make sure the employees sign off on their training and keep those on file. If the employee requests a copy of the sign off employers are now responsible to give them one copy.

Central Location
The big change here is the need to keep SDS sheets (Safety Data Sheets). Many of you are unfamiliar with SDS sheets but they are the old MSDS sheets in a standardized format.

You will need to “display” them at the central location for 30 days following their use. Keeping them in a loose leaf notebook at the central location is acceptable. You need to keep these SDS sheets for two years after they were last used. You can get the SDS sheets from your pesticide supplier or download them off the Internet.

Of course you will still need to keep pesticide application information for 30 days at the central location and the pesticide safety information (poster). The central location must be easily accessible to your employees.

Protection Against Retaliatory Acts
Requirements of this subpart 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.

We will return to the Revised WPS in a few sections…

Four Basic WPS Requirements

These regulations contained four basic requirements:
(1) workers are not to be sprayed with pesticides;

(2) there are specific restricted entry intervals (REI) for serval pesticides, interim restrictive entry levels for certain pesticides, and a general re-entry interval for all other agricultural pesticides prohibiting re-entry into treated areas until sprays have dried, dusts have settled, and vapors have dispersed;

(3) protective clothing is required for any worker entering a treated area before the specific re-entry period has expired; and

(4) "appropriate and timely" warnings are required for re-entry. These warnings may be given orally in appropriate language, placed on the pesticide notice board, or posted in the field.

1974 Regulations
The EPA determined that the 1974 regulations did not adequately protect agricultural workers and pesticide handlers who were occupationally exposed to pesticides. In order to correct these inadequacies, the EPA issued new regulations designed to reduce exposure to pesticides, mitigate exposure, and inform workers about pesticides.

Reducing overall exposure to pesticides will be accomplished by prohibiting handlers from exposing workers during application, excluding workers from areas being treated and areas under a REI (some activities are allowed during a REI if workers are properly trained and protected), and notifying workers about treated areas.

Mitigating Exposures
Mitigating exposures will be accomplished by requiring decontamination supplies and emergency assistance.

Workers will be informed about pesticide hazards through required safety training (workers and handlers), safety posters, access to labeling information, and access to specific information (listing of treated areas on the establishment).

Worker Protection Standard for Agricultural Pesticides
Provisions of the WPS apply to:

Owners or managers of farms, forests, nurseries, or greenhouses where pesticides are used in the production of agricultural plants.

Those who hire or contract for services of agricultural workers to do tasks related to the production of agricultural plants on a farm, forest, nursery, or greenhouse.

What Does the Revised WPS Require?

The requirements in the WPS are intended to inform workers and handlers about pesticide safety, provide protections from potential exposure to pesticides, and mitigate exposures that do occur.

- Pesticide safety training for workers and handlers.
- Access to labeling information for pesticide handlers and early-entry workers.
- Access to specific information for workers and handlers, which includes providing information about:
    - pesticide applications on the establishment,
    - emergency information, and
    - a pesticide safety poster at a central location;
- Keep workers out of areas being treated with pesticides.
- Keep workers out of areas that are under a restricted-entry interval (REI), with a few narrow exceptions.
- Protect early-entry workers who are doing permitted tasks in pesticide-treated areas during an REI, including special instructions and duties related to correct use of personal protective equipment.
- Notify workers about pesticide-treated areas so they can avoid inadvertent exposures.
- Monitor handlers using highly toxic pesticides.
- Provide required personal protective equipment to handlers.
- Decontamination supplies a sufficient supply of water, soap, and towels for routine washing and emergency decontamination.
- Emergency assistance making transportation available to a medical care facility in case of a pesticide injury or poisoning, and providing information about the pesticide(s) to which the person may have been exposed.

Who is Covered by the 2015 WPS?

The WPS protects employees on farms, forests, nurseries, and greenhouses from occupational exposure to agricultural pesticides and covers two types of employees:

- Pesticide handlers: those who mix, load, or apply agricultural pesticides; clean or repair pesticide application equipment; or assist with the application of pesticides.
- Agricultural workers: those who perform tasks related to growing and harvesting plants on farms or in greenhouses, nurseries, or forests.

General Duties of WPS

The general duties of the WPS require an agricultural employer or a pesticide handler-employer to:

- Assure that each worker and handler subject to the standard receives the required protections.

- Assure that any pesticide subject to the standard is used in a manner consistent with the labeling of the pesticide, including the requirements in the standard.

- Provide sufficient information and directions to each person who supervises any worker or handler to assure that each worker or handler receives the required protection. The information and directions must specify which persons are responsible for actions required to comply with the standard.

- Require each person who supervises any worker or handler to assure compliance by the worker or handler with the provisions of this standard and to assure that the worker or handler receives the required protection (40 CFR).

- The general duties also prohibit agricultural and handler employers from taking any retaliatory actions against workers attempting to comply with this standard, or from taking any action that prevents or discourages any worker or handler from complying or attempting to comply with the WPS.

Labeling
Requires everyone applying pesticides to obey instructions printed on the pesticide container's label.

Understanding the Worker Protection Standard?

The Worker Protection Standard (WPS) is a regulation issued by the U.S. Environmental Protection Agency. It covers pesticides that are used in the production of agricultural plants on farms, forests, nurseries, and greenhouses. The WPS requires you to take steps to reduce the risk of pesticide-related illness and injury if you (1) use such pesticides, or (2) employ workers or pesticide handlers who are exposed to such pesticides.

If you are an agricultural pesticide user and/or an employer of agricultural workers or pesticide handlers, the WPS requires you to provide to your employees and, in some cases, to yourself and to others:

- information about exposure to pesticides,
- protections against exposures to pesticides, and
- ways to mitigate exposures to pesticides.

General Information
To ensure that employees will be informed about exposure to pesticides, the WPS requires:
• **Pesticide safety training** — for workers and handlers,
• **Pesticide safety poster** — to be displayed for workers and handlers,
• **Access to labeling information** — for pesticide handlers and early-entry workers, and
• **Access to specific information** — centrally located application information of pesticide treatments on the establishment.

WPS Protection
To ensure that employees will be protected from exposures to pesticides, the WPS requires employers to:
• **prohibit handlers from applying a pesticide in a way that will expose workers or other persons**,
• **exclude workers from areas being treated** with pesticides,
• **exclude workers from areas that remain under a restricted-entry interval (REI)**, with narrow exceptions.
• **protect early-entry workers** who are doing permitted tasks in treated areas during an REI, including special instructions and duties related to correct use of PPE,
• **notify workers** about treated areas so they can avoid inadvertent exposures, and
• **protect handlers during handling tasks**, including monitoring while handling highly toxic pesticides, and duties related to correct use of PPE.

These key terms have very specific meanings in the WPS. Note that these definitions may be different from definitions found in other state and federal laws and regulations.

Mitigation
To mitigate pesticide exposures that employees receive, the WPS requires:
• **Decontamination supplies** — providing handlers and workers an ample supply of water, soap, and towels for routine washing and emergency decontamination.
• **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.

These key terms have very specific meanings in the WPS. Note that these definitions may be different from definitions found in other state and federal laws and regulations.

Terms You Need to Know
These definitions will help you determine whether you are affected by the Worker Protection Standard. *These key terms have very specific meanings in the WPS. Note that these definitions may be different from definitions found in other state and federal laws and regulations.*

Agricultural plants: Plants grown or maintained for commercial or research purposes. Examples: food, feed, and fiber plants, trees, turfgrass, flowers, shrubs, ornamentals, and seedlings.

Farms: Operations, other than nurseries or forests, which produce agricultural plants outdoors.

Forests: Operations that produce agricultural plants outdoors for wood fiber or timber products.

Greenhouses: this term has been replaced by **Enclosed space production -** production of an agricultural plant indoors or in a structure or space that is covered in whole or in part by any nonporous covering and that is large enough to permit a person to enter.

Fumigant – any pesticide that is a vapor or gas, or forms

Nurseries: Operations that produce agricultural plants outdoors for:
- transplants to another location, or
- flower or fern cuttings.

Examples: flowering and foliage plants or trees; tree seedlings; live Christmas trees; vegetable, fruit, and ornamental transplants; and turfgrass produced for sod.

Does the Worker Protection Standard Apply to you?

• You own or manage a farm, forest, nursery, or greenhouse where pesticides are used in the production of agricultural plants.
Even if you are the owner of the farm, forest, nursery, or greenhouse and you or members of your family do all the work there, you are a "WPS employer." You must comply with ***some*** of the requirements described in this manual, such as restricted-entry intervals and personal protective equipment, and ***all*** the specific requirements listed in the pesticide labeling. See Agricultural Owner Exemptions, for more information.

• You hire or contract for the services of agricultural workers to do tasks related to the production of agricultural plants on a farm, forest, nursery, or greenhouse. This includes labor contractors and others who contract with growers to supply agricultural laborers.

• You operate a business in which you (or people you employ) apply pesticides
that are used for the production of agricultural plants on any farm, forest, nursery, or greenhouse.

Commercial pesticide handlers and their employees are included with respect to such pesticides even if the pesticide handling task (mixing, loading, disposal, etc.) takes place somewhere other than the farm, forest, nursery, or greenhouse — at the commercial handling establishment or an airport hangar, for example.

• You operate a business in which you (or people you employ) perform tasks as a crop advisor on any farm, forest, nursery, or greenhouse.
"Crop advisor" means any person who is assessing pest numbers or damage, pesticide distribution, or the status, condition, or requirements of agricultural plants. Examples include crop consultants and scouts.

If you are in any of these categories, you must comply with the Environmental Protection Agency's Worker Protection Standard (40 CFR, part 170) including all revisions through 2004.

Under the WPS, you may be both a worker and an employer of workers.

Under the WPS, you may be both a handler and an employer of handlers.

EXAMPLE OF WARNING SIGNS USED IN PESTICIDE APPLICATION

Who Does the WPS Protect?

The WPS requires employers to take steps to protect two types of agricultural employees: **workers** and **pesticide handlers**. The terms “worker” and “pesticide handler” are defined very specifically in the WPS, and employers of persons who meet these definitions must comply with the WPS. Depending on the tasks being performed, you may need to provide the same employee with worker protections on some occasions and pesticide handler protections on other occasions.

Who is Covered by the WPS?
The WPS protects employees on farms, forests, nurseries, and greenhouses from occupational exposure to agricultural pesticides and covers two types of employees:

- Pesticide handlers: those who mix, load, or apply agricultural pesticides; clean or repair pesticide application equipment; or assist with the application of pesticides.
- Agricultural workers: those who perform tasks related to growing and harvesting plants on farms or in greenhouses, nurseries, or forests.

Workers
Worker means any person, including a self-employed person, who is employed for any type of compensation and who is performing activities relating to the production of agricultural plants on an agricultural establishment to which subpart B of this part applies.

While persons employed by a commercial pesticide handling establishment are performing tasks as crop advisors, they are not workers covered by the requirements of subpart B of this part.

Pesticide Handlers

A pesticide handler is anyone who: (1) is employed (including self-employed) for any type of compensation by an agricultural establishment or a commercial pesticide handling establishment that uses pesticides in the production of agricultural plants on a farm, forest, nursery, or greenhouse, and (2) is doing any of the following tasks:

- mixing, loading, transferring, or applying pesticides,
- handling opened containers of pesticides,
- acting as a flagger,
- cleaning, handling, adjusting, or repairing the parts of mixing, loading, or application equipment that may contain pesticide residues,
- assisting with the application of pesticides, including incorporating the pesticide into the soil after the application has occurred,
- entering a greenhouse or other enclosed area after application and before the inhalation exposure level listed on the product labeling has been reached or one of the WPS ventilation criteria have been met to: – operate ventilation equipment, – adjust or remove coverings, such as tarps, used in fumigation, or – check air concentration levels,
- entering a treated area outdoors after application of any soil fumigant to adjust or remove soil coverings, such as tarpaulins,
- performing tasks as a crop advisor: – during any pesticide application, – before any inhalation exposure level or ventilation criteria listed in the labeling has been reached or one of the WPS ventilation criteria has been met, – during any restricted-entry interval,
- disposing of pesticides or pesticide containers.

Definition of a Pesticide Handler

The Agricultural Worker Protection Standard (WPS) is a regulation issued by the U.S. Environmental Protection Agency in 1992 and amended in 2015. It covers pesticides that are used in the production of agricultural plants on farms, forests, nurseries, and greenhouses. The WPS requires you to take steps to reduce the risk of pesticide-related illness and injury if you (1) use such pesticides, or (2) employ workers or pesticide handlers who are exposed to such pesticides.

By explaining what types of workers are considered "pesticide handlers" under this regulation, this fact sheet will help you understand who you must legally provide protections for.

Who is a Handler?

Handler means any person, including a self-employed person:

(1) Who is employed for any type of compensation by an agricultural establishment or commercial pesticide handling establishment to which subpart C of this part applies and who is:

(i) Mixing, loading, transferring, or applying pesticides.

(ii) Disposing of pesticides or pesticide containers.

(iii) Handling opened containers of pesticides.

(iv) Acting as a flagger.

(v) Cleaning, adjusting, handling, or repairing the parts of mixing, loading, or application equipment that may contain pesticide residues.

(vi) Assisting with the application of pesticides.

(vii) Entering a greenhouse or other enclosed area after the application and before the inhalation exposure level listed in the labeling has been reached or one of the

ventilation criteria established by this part (§170.110(c)(3)) or in the labeling has been met:
(A) To operate ventilation equipment.
(B) To adjust or remove coverings used in fumigation.
(C) To monitor air levels.
(viii) Entering a treated area outdoors after application of any soil fumigant to adjust or remove soil coverings such as tarpaulins.
(ix) Performing tasks as a crop advisor:
(A) During any pesticide application.
(B) Before the inhalation exposure level listed in the labeling has been reached or one of the ventilation criteria established by this part (§170.110(c)(3)) or in the labeling has been met.
(C) During any restricted-entry interval.
(2) The term does not include any person who is only handling pesticide containers that have been emptied or cleaned according to pesticide product labeling instructions or, in the absence of such instructions, have been subjected to triple-rinsing or its equivalent.

Handler employer means any person who is self-employed as a handler or who employs any handler, for any type of compensation.

Who is not a Handler?
A person is NOT a handler if he or she only handles pesticide containers that have been emptied or cleaned according to instructions on pesticide product labeling or, if the labeling has no such instructions, have been triple-rinsed or cleaned by an equivalent method, such as pressure rinsing.

A person is NOT a handler if he or she (1) is ONLY handling pesticide containers that are unopened AND (2) is NOT, at the same time, also doing any handling task (such as mixing or loading).

Examples:
1. You ARE a handler if you are loading unopened water-soluble packets into a mixing tank (because you are mixing and loading the pesticide).
2. You are NOT a handler if you:
    - purchase pesticides and transport them unopened to an establishment.
    - carry unopened containers into a pesticide storage facility.
    - transport unopened containers to the site where they are to be mixed, loaded, or applied.

Certified Applicators
Handlers who are currently certified as applicators of restricted-use pesticides must be given all of the WPS handler protections, except that they need not receive WPS training.

Worker Protection Standard Compliance Monitoring Program
The Worker Protection Standard (WPS) is a regulation issued by the U.S. Environmental Protection Agency to protect agricultural workers from the effects of exposure to pesticides.

It covers pesticides that are used in the production of agricultural plants on farms, forests, nurseries, and greenhouses. The WPS offers protections to over three and a half million people who work with pesticides at over 560,000 workplaces.

The scope of the regulation includes both workers performing in areas treated with pesticides and those who handle (mix, load, apply, etc.) pesticides in these locations.

Agricultural establishments are defined by 40 CFR § 170.3, as farms, nurseries, greenhouses, and forests. Routine WPS agricultural inspections are conducted at agricultural establishments to ensure users of pesticides subject to WPS comply with requirements of product label(s) by examining practices of agricultural and handler employers and their employees to ensure that they are in compliance with:

1. product-specific WPS requirements as prescribed on pesticide product labeling [personal protective equipment (PPE), Restricted Entry Intervals (REIs), and oral and posted warnings used on the establishment] and;
2. generic WPS requirements incorporated by the reference statement that appears on the labeling (pesticide safety information, decontamination supplies, safety training, emergency assistance, and worker notification).

The goals in conducting WPS agricultural inspections include:

- monitoring employer compliance
- documenting violations
- addressing noncompliance
- and increasing handler/worker safety

WPS inspections should be performed during the significant periods of the agricultural production season, such as:

- during and after pesticide application;
- during an restricted entry interval (REI);
- after an REI has expired plus 30 days.

Noncompliance with WPS may result in pesticide violations—specifically, FIFRA § 12(a)(2)(G) and defined by FIFRA § 2(ee), whereby it is unlawful for any person "to use any registered pesticide in a manner inconsistent with its labeling."

Accomplishments and Violations Reports

EPA provides guidelines on reporting WPS compliance monitoring and enforcement activities conducted under the its Cooperative Agreement program. States and tribes are required to report specific information on WPS agriculture use inspections and enforcement actions.

EPA provides a national view on the implementation status of the WPS program in the annual Worker Protection Standard (WPS) Inspection and Enforcement Accomplishments Reports. The data is submitted by states and tribes or regional program staff in instances where EPA manages the WPS program.

Violations on the ten specific WPS violation categories that each enforcement action covered is also included. The data on WPS violation categories provides information for inspection targeting and for directing training to areas of the WPS rule most frequently violated.

Not a Handler

A person is ***not*** a handler if he or she only handles pesticide containers that have been emptied or cleaned according to instructions on pesticide product labeling or, if the labeling has no such instructions, have been triple-rinsed or cleaned by an equivalent method, such as pressure rinsing.

A person is ***not*** a handler if he or she (1) is ***only*** handling pesticide containers that are unopened ***and*** (2) is ***not***, at the same time, also doing any handling task (such as mixing or loading).

• You are ***not*** a handler if you:
– purchase pesticides and transport them unopened to an establishment.
– carry unopened containers into a pesticide storage facility.
– transport unopened containers to the site where they are to be mixed, loaded, or applied.

You ***are*** a handler if you are loading unopened water-soluble packets into a mixing tank (because you are mixing and loading the pesticide).

Who Is an Agricultural Employer?

Agricultural employer means any person who hires or contracts for the services of workers, for any type of compensation, to perform activities related to the production of agricultural plants, or any person who is an owner of or is responsible for the management or condition of an agricultural establishment that uses such workers.

Additional Duties for Agricultural Employers Duties 2015-2018

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 (I)

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
Citation 28. & 36.a.-36.b. -36.c
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)

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.

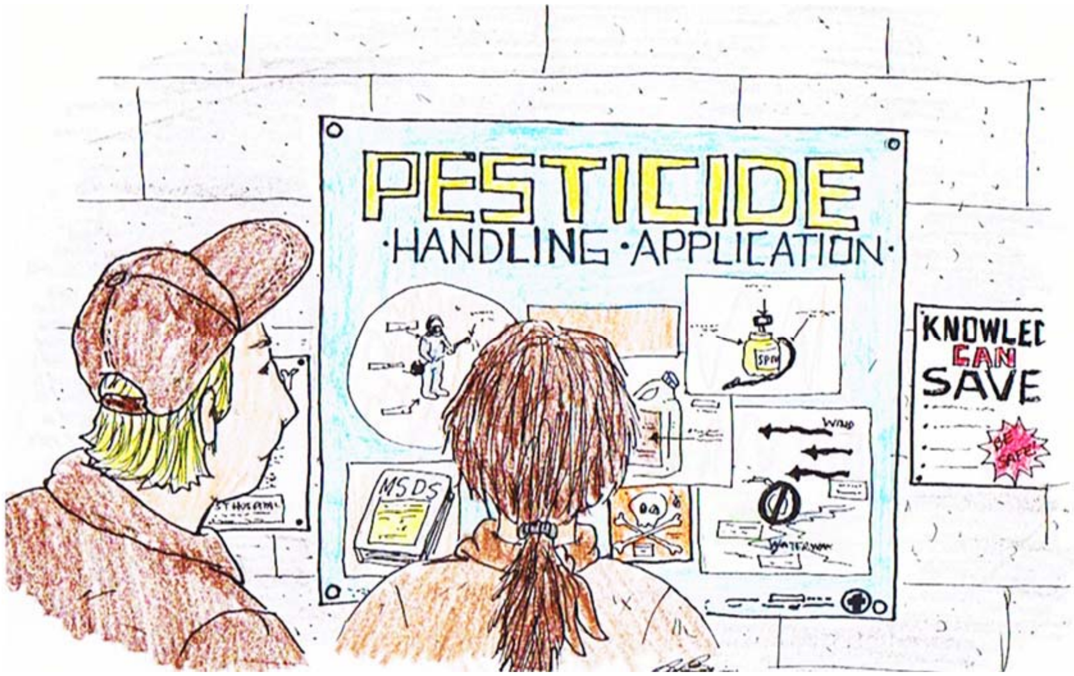
The training must include, at a minimum, all of the following after January 2, 2017:

- 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.

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.

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.

Short Summary of WPS Requirements



The requirements in the WPS are intended to inform workers and handlers about pesticide safety, provide protections from potential exposure to pesticides, and mitigate exposures that do occur.

- Pesticide safety training for workers and handlers.
- Access to labeling information for pesticide handlers and early-entry workers.
- Access to specific information for workers and handlers, which includes providing information about:
    - pesticide applications on the establishment,
    - emergency information, and
    - a pesticide safety poster at a central location;
- Keep workers out of areas being treated with pesticides.
- Keep workers out of areas that are under a restricted-entry interval (REI), with a few narrow exceptions.
- Protect early-entry workers who are doing permitted tasks in pesticide-treated areas during an REI, including special instructions and duties related to correct use of personal protective equipment.
- Notify workers about pesticide-treated areas so they can avoid inadvertent exposures.
- Monitor handlers using highly toxic pesticides.
- Provide required personal protective equipment to handlers.
- Decontamination supplies a sufficient supply of water, soap, and towels for routine washing and emergency decontamination.
- Emergency assistance making transportation available to a medical care facility in case of a pesticide injury or poisoning, and providing information about the pesticide(s) to which the person may have been exposed.

“**Agricultural Use Requirements -** Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment, notification of workers, and restricted entry intervals.”

Pesticides used on sod farms are covered by WPS.

Some pesticide uses are not covered by WPS, even when the Agricultural Use Requirements section is on the labeling. For example, if the pesticide labeling bears an Agricultural Use Requirements section, but the product also can be applied to rights-of-way, the rights-of-way use is not covered by WPS.

WPS Requires Restricted Entry to Treated Areas
Restricted-entry interval (**REI**) is the time immediately after a pesticide application when entry into the treated area is prohibited or very limited. REIs are established for all pesticides used in the production of agricultural plants depending on toxicity. The REI 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.

REIs must be specified on all agricultural plant pesticide product labels. Workers are excluded from entering a pesticide treated area during the REI, with few narrow exceptions. The duration of REIs ranges from 4 hours to several days. 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, the longer interval must be followed.
There is a no-entry period for 4 hours for all products with WPS labeling; this means no early entry.

• Annual mandatory training to inform farmworkers on the required protections. This increases the likelihood that protections will be followed.
• Expanded training includes instructions to reduce take-home exposure from pesticides on work clothing and other safety topics.
• First-time ever minimum age requirement: Children under 18 are prohibited from handling pesticides.
• Expanded mandatory posting of no-entry signs for the most hazardous pesticides. The signs prohibit entry into pesticide-treated fields until residues decline to a safe level.
• New no-entry application-exclusion zones up to 100 feet surrounding pesticide application equipment will protect workers and others from exposure to pesticide overspray.
• Requirement to provide more than one way for farmworkers and their representatives to gain access to pesticide application information and safety data sheets – centrally-posted, or by requesting records.

WPS Requires Notification of Applications
Employers must notify workers about pesticide applications on the agricultural establishment if they will be on or within a quarter (1/4) mile of the treated area. In most cases, employers may choose between oral warnings or posted warning signs, but they must tell workers which warning method is in effect. All applications must be additionally recorded and displayed at the central location.

Most products allow worker notification either orally or by posting a field warning sign, one or the other is acceptable as long as workers are informed of which method is being used. However, you must provide double notification if the pesticide label has this statement in the "Directions for Use" section 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."
If double notification is specified on the pesticide label workers must be orally notified about REIs and treated fields must be physically posted with warning signs during the REI. It is the agricultural establishment's responsibility to post warning signs in the field if it is required. Farms employing ONLY immediate family members are not required to post the field.

Signs must have the words "**Danger-Peligro**" and "**Pesticides-Pesticidas**" at the top and "Keep Out-No Entre" at the bottom. Signs must be at least 14" x 16", with a minimum letter height of one inch.

The Spanish portion of the sign may be replaced with a substitute language read by the majority of non-English speaking workers. In greenhouses and nurseries, smaller signs (4.5" x 5") are acceptable.

Warning signs must be:
- Posted 24 hours or less before application
- Removed within three (3) days after the end of the REI
- Posted so they can be seen at all normal entrances to treated areas, including borders adjacent to labor camps

- If no employees were involved with treatment, or the employees do not come within a quarter (1/4) mile, no posting is required

Oral warnings must be delivered in a manner understood by workers, using an interpreter if necessary. Oral warnings must contain the following information:

- Location and description of the treated area
- The length of the REI
- Specific directions not to enter during the REI

WPS Requires That Specific Information Regarding Applications and Safety Be Posted at a Central Location

The WPS requirement that information be posted (displayed) at a central location is cited by the EPA as one of the most commonly violated provisions.

When pesticides are released into the environment, they are either:
1) broken down, or degraded, by the action of sunlight, water or other chemicals, or microorganisms, such as bacteria; or
2) resist degradation and thus remain unchanged in the environment for long periods of time. The persistence of a pesticide is its ability to remain unchanged.

Persistence is measured by half-life. The half-life is the time it takes for half of the initial amount of a pesticide to break down. Thus, if a pesticide's half-life is 30 days, half will be left after 30 days, one-quarter after 60 days, and one-eighth after 90 days and so on.

When the pesticide is broken down, this usually leads to the formation of less harmful products. However, in some instances the products can be more toxic than the original pesticide.

Pesticides that are easily broken down generally move the shortest distance and have the least adverse effects on people or other organisms. Persistent pesticides generally move the longest distances and have the greatest potential to accumulate in living organisms.

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.

This is a very controversial rule and there will be much needed interpretation on this section.

Special Applications Restrictions in Nurseries and Greenhouses

Greenhouses are now referred to as Growing Enclosures.
The WPS requires additional restrictions during some pesticide applications in nurseries and greenhouses. This part describes those restrictions.

Worker employers must make sure that, during certain nursery applications, **workers and other persons** do not enter treated areas on the nursery or, in some circumstances, do not enter areas that are near the treated area.

Specific Duties - Application Restrictions on Nurseries
During any application do not allow or direct any person, other than an appropriately trained and equipped handler, to be in the areas on the nursery.

After the application is finished and during the restricted-entry interval:
- keep workers out of the treated area (the area to which the pesticide was directed),
- you may allow workers in the areas just outside the treated area that were off-limits during the application.

Worker employers must make sure that **workers and other persons** do not enter specific areas within the greenhouse during — and, in some instances, after — certain greenhouse applications.

Ventilation Criteria for Greenhouses
1. After some types of pesticide applications listed in column A of Table II, you must make sure that adequate ventilation has occurred before you allow workers to enter the areas specified in column B.

If column C indicates that ventilation restrictions apply, **make sure that one of the following ventilation criteria is met**:
- The concentration of the pesticide in the air is measured to be less than or equal to any inhalation exposure level required on the labeling.
- If no inhalation exposure level is listed on the labeling, keep workers out until after: – 10 air exchanges, or – 2 hours of ventilation using fans or other mechanical ventilating systems, or – 4 hours of ventilation using vents, windows or other passive ventilation, or – 11 hours with no ventilation followed by 1 hour of mechanical ventilation, or – 11 hours with no ventilation followed by 2 hours of passive ventilation, or – 24 hours with no ventilation.

2. **After ventilation criteria are met** and until the restricted entry interval expires:
- do not allow workers into the treated area (see Column D on Table II),
- you may allow workers to enter the areas just outside the treated area that were off-limits during the application.

Part C Early Work
The WPS allows entry into a treated area that remains under a restricted-entry interval only in a few narrow work situations. When early entry is permitted under the WPS, special protections must be given to the early-entry workers. This subsection describes those work situations and protections.

WPS - Information Exchange between Commercial Handlers and Growers

When the Pesticide Is Not Applied as Scheduled

The Agricultural Worker Protection Standard (WPS) is a regulation issued by the U.S. Environmental Protection Agency in 1992 and amended in 2015. It covers pesticides that are used in the production of agricultural plants on farms, forests, nurseries, and greenhouses. The WPS requires you to take steps to reduce the risk of pesticide-related illness and injury if you (1) use such pesticides, or (2) employ workers or pesticide handlers who are exposed to such pesticides.

The WPS requires commercial handlers (handler employers) to provide information to their customers -- the farm, forest, nursery, or greenhouse operators (agricultural employers) -- about the pesticide before it is applied. [40 CFR section 170.224]. What provisions apply if the pesticide cannot be applied as scheduled?

The WPS requires the commercial handler to provide specific information to the grower about pesticide applications on the agricultural establishment before the application has taken place. This is so the grower can, in turn, provide appropriate protection to his/her workers and family. The Agency is aware, however, that some commercial handlers may on occasion not be able to perform pesticide applications at a previously scheduled time.

The "How to Comply" manual provided some flexibility on this issue, noting that "if the pesticide is not applied as scheduled, the agricultural employer must be informed of the corrected time and date of the application. Make the correction before the application takes place, or as soon as practicable thereafter." Questions have arisen concerning the notification requirements if applications do not take place as scheduled, including when and how the employer must be notified of the change.

The WPS places certain requirements upon growers (agricultural employers). One of the most important requirements involves keeping workers out of treated areas during applications and while the restricted entry interval (REI) remains in effect.

Growers also must provide workers with (among other things) information, protective equipment, and decontamination supplies when they enter treated fields within 30 days of expiration of the REI. The requirement for commercial handlers to notify growers before an application takes place must be viewed in light of its central purpose: to provide growers with information they may need in order to protect their workers.

The obligation of growers to assure that workers remain out of treated areas during applications and while the REI remains in effect, and to assure that proper protections are provided when workers enter treated areas within 30 days of expiration of the REI, is not affected by the notification provision. The obligation of the grower continues whether or not notification of an application occurs. The grower should take whatever steps are necessary to assure that he/she is informed of an application before workers might enter treated areas. Obviously, notification before application is the best way to assure that the grower has the necessary information to protect the agricultural employees. For this reason, the WPS requires that notification take place before applications. Commercial handlers are liable under the WPS if they fail to provide such notification.

WPS -Central Posting on Large or Non-contiguous Establishments

The Agricultural Worker Protection Standard (WPS) is a regulation issued by the U.S. Environmental Protection Agency in 1992 and amended in 2015. It covers pesticides that are used in the production of agricultural plants on farms, forests, nurseries, and greenhouses. The WPS requires you to take steps to reduce the risk of pesticide-related illness and injury if you (1) use such pesticides, or (2) employ workers or pesticide handlers who are exposed to such pesticides. This fact sheet will help you understand how to comply with WPS requirements for displaying information about pesticide applications. These questions were submitted to the Agency by people seeking clarification on this part of the regulation, and have been answered by EPA's Office of Compliance.

What is required for central posting when an agricultural establishment is particularly large or has separate workforces on non-contiguous sites?
The rule requires that certain information (30-day listing of pesticide applications and associated REIs, safety poster, and emergency medical care information) must be displayed in a central location on the agricultural establishment, in a place accessible to workers and handlers. EPA anticipated that there would be one central posting location on the agricultural establishment.

However, if because of the size of the establishment or the separate nature of the workforce, there is not one central location that is accessible to all workers, then an employer will need more than one central posting to comply with the accessibility requirement in the rule.

By accessible, EPA means that the information must be in a location where it can be readily seen and read and must be unrestricted in that it need not be requested.

When an agricultural employer uses more than one central location on the agricultural establishment, what information may be provided at each location?
The agricultural employer has two options.

Option 1 is to post complete information for the entire establishment at all locations.

Option 2 is to post information on applications made only to the part of the agricultural establishment served by the central location, if the following conditions are met:

1. Each central location clearly indicates the area covered by the application list. The central posting states that it is site-specific and is only a partial listing of the applications on the establishment. The posting makes clear that there are other central locations.
2. Any worker or noncommercial handler that enters any area of the agricultural establishment has been informed of the central location covering that area.
3. Each central location meets all other WPS requirements for a central location including display of a safety poster and emergency information.

Note: If an agricultural employer has a central posting location displaying information about all applications, he/she may post site-specific information at other locations on the establishment. The above three conditions do not have to be met for this additional information.

WPS - Basic Information about Central Posting

Agricultural employers must display certain information, described below, at a central location whenever any worker or handler they employ is on their agricultural establishment **and**, within the past 30 days, a WPS-labeled pesticide product has been applied or a restricted-entry interval (REI) for such pesticide has been in effect. 170.309(h)

The requirement to display information is not applicable to commercial pesticide handler employers.

What information must be displayed?
170.311(a)&(b)

Pesticide safety information can be a poster developed by EPA, or an equivalent way of providing the required WPS pesticide safety concepts.

Pesticide application information including:

- ✓ Name of the pesticide applied,
- ✓ Active ingredient(s),
- ✓ EPA registration number,
- ✓ REI,
- ✓ Crop or site treated,
- ✓ Location and description of the treated area(s), and
- ✓ Date(s) and times application started and ended.

Hazard information consists of a copy of the OSHA Safety Data Sheet (SDS) for each pesticide product.

Where must the information be displayed? 170.311(a)(5) and 170.311(b)(2)&(3)
Pesticide safety, application, and hazard information must be displayed at a central location on an agricultural establishment that is readily accessible at all times during normal work hours and can be easily seen and read by workers and handlers. Usually this is a location where employees congregate such as where they check in or out of work, change clothes, eat, etc.
In addition, only pesticide safety information must be displayed at:
- Any permanent decontamination site, and
- Any location where decontamination supplies are required in quantities for 11 or more workers.

When must the information be displayed? 170.309(h) & (l) and 170.311(b)(5)
Display pesticide safety information:
- Whenever any worker or handler employee is on the agricultural establishment, and
- When, within the past 30 days, a WPS-labeled pesticide product has been applied or a restricted-entry interval (REI) for such pesticide has been in effect.

Display pesticide application and hazard information:
- Within 24 hours after the end of the application if workers or handlers are on the agricultural establishment.

Continue to display the pesticide application and hazard information when workers or handlers are on the establishment until:
- At least 30 days after the REI expires, or
- At least 30 days after the end of the application, if there is no REI for the pesticide, or
- Workers and handlers are no longer on the establishment - if it is less than 30 days after the end of the last applicable REI.

Other employer responsibilities
- Inform workers and handlers where the pesticide safety, application and hazard information is located. 170.403 & 170.503
- Allow workers and handlers unrestricted access to the posted information. 170.311(a)(6) & (b)(3)
- Ensure the pesticide safety information and pesticide application information remains legible the entire time they are posted. 170.311(a)(7) & (b)(4)
- Update the emergency medical facility information listed with the poster within 24 hours of obtaining new information. 170.311(a)(4)

Federal Pesticide Recordkeeping Requirements

New 2015 Requirements
For Workers
(1) For each worker required to be trained under paragraph (a), the agricultural employer must maintain on the agricultural establishment, for two years from the date of the training, a record documenting each worker's training including all of the following:
(i) The trained worker's printed name and signature.
(ii) The date of the training.
(iii) Information identifying which EPA-approved training materials were used.
(iv) The trainer's name and documentation showing that the trainer met the requirements of §170.401(c)(4) at the time of training.
(v) The agricultural employer's name.
(2) An agricultural employer who provides, directly or indirectly, training required under paragraph (a) must provide to the worker upon request a copy of the record of the training that contains the information required under §170.401(d)(1).

For Pesticide Worker Trainers
The person who conducts the training must have one of the following qualifications:
(i) Be designated as a trainer of certified applicators or pesticide handlers by EPA or the State or Tribal agency responsible for pesticide enforcement.
(ii) Have completed an EPA-approved pesticide safety train-the-trainer program for trainers of handlers.
(iii) Be currently certified as an applicator of restricted use pesticides under part 171 of this chapter.
(d) *Recordkeeping.* (1) Handler employers must maintain records of training for handlers employed by their establishment for two years after the date of the training. The records must be maintained on the establishment and must include all of the following information:
(i) The trained handler's printed name and signature.
(ii) The date of the training.
(iii) Information identifying which EPA-approved training materials were used.
(iv) The trainer's name and documentation showing that the trainer met the requirements of §170.501(c)(4) at the time of training.
(v) The handler employer's name.
(2) The handler employer must, upon request by a handler trained on the establishment, provide to the handler a copy of the record of the training that contains the information required under §170.501(d)(1).

Related 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.

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.

Agricultural Pesticide Application Post Quiz

New and Required EPA Information

1. All agricultural employers whose workers perform hand labor operations in fields, forests, nurseries, and greenhouses treated with pesticides, and handle pesticides in these locations are covered by the U.S. Environmental Protection Agency's worker protection standard revised in ________________.

Changes to EPA's Farm Worker Protection Standard

2. The regulation seeks to protect and reduce the risks of injury or illness resulting from agricultural workers' (those who perform_______________ , such as harvesting, thinning, pruning) and pesticide handlers' (those who mix, load and apply pesticides) use and contact with pesticides on farms, forests, nurseries and greenhouses. The regulation does not cover persons working with livestock.

Employers covered by the WPS must:

3. Reduce overall exposure to pesticides by prohibiting handlers from exposing workers during pesticide application, excluding workers from areas being treated and areas under a restricted entry interval, and__________________. Some activities are allowed during restricted entry intervals if workers are properly trained and protected.

Agricultural Employers Responsibility
We will go in to great detail on this rule and its requirement.
New WPS Requirements 2015-2018

4. Annual mandatory training to inform farmworkers on the required protections. This increases the likelihood that ____________________ will be followed.

What Will These Changes Achieve?

5. There is a clear need for ____________ for farmworkers. Each year, between 1,800 and 3,000 occupational incidents involving pesticide exposure are reported from the farms, forests, nurseries and greenhouses covered by the Worker Protection Standard. There is widespread underreporting.

What Types of Activities Are Covered?

6. The regulation seeks to protect and reduce the risks of injury or illness resulting from agricultural workers' (those who perform hand-labor tasks in pesticide-treated crops, such as harvesting, thinning, pruning) and pesticide handlers' (those who mix, load and apply pesticides) use and contact with pesticides on farms, forests, nurseries and greenhouses. The regulation does not cover ______________working with livestock.

Family Exemption

7. There is an “immediate family” exemption to the WPS that exempts family members from MOST of the WPS protections. However, family members must still use label required _________ and still must obey the REIs (Restricted Entry Intervals) and the other label requirements.

So who falls under the Family Exemption?

8. The regulation revision has expanded the ______________to now include first cousins, nephews, nieces, aunts, uncles, grandchildren, grandparents and in-laws. The original exemptions are still valid and they include children, step children, foster children, parents, step parents, foster parents, siblings and spouses and of course the owner.

Labeling

9. Requires ___________applying pesticides to obey instructions printed on the pesticide container's label.

Understanding the Worker Protection Standard?

10. The Worker Protection Standard (WPS) is a regulation issued by the U.S. Environmental Protection Agency. It covers pesticides that are used in the production of agricultural plants on farms, forests, nurseries, and enclosed production spaces. The ____________ requires you to take steps to reduce the risk of pesticide-related illness and injury if you (1) use such pesticides, or (2) employ workers or pesticide handlers who are exposed to such pesticides.

Answers

1. Good coverage, 2. Aerial spraying, 3. IGR, 4. Hexaflumuron, 5. Diflubenzuron, 6. Pyriproxyfen, 7. IPM, 8. Preventive cultural practices, 9. Augmentative control, 10. Penetrating agents

Aerial Application Section

The aerial application of pesticides has several advantages for the modern agricultural producer. When properly managed, aerial application offers speed of dispersal, accessibility to crops on which ground equipment cannot operate, and reasonable cost. In many cases, the advantages also include more timely applications and, therefore, better utilization of pesticide materials.

You can cover large areas quickly. You can treat crops or areas (such as mid-season corn or forest stands) for which ground equipment isn't suitable; and the application cost per acre is comparatively low. Before applying pesticides by aircraft, you must have a valid pilot's certificate, and you or your employer must have a valid agricultural aircraft operator's certificate.

The full advantages of aerial application are more likely to be realized when its use is preplanned. Development of a planned aerial application program will require good cooperation between pilot and grower. It should be based upon the grower's specific problems and the overall scope of his operation. Any plan must also recognize the potential dangers to people, other crops and the environment. After a plan has been developed, it is essential that it be followed as closely as possible in order to return maximum benefits to both the producer and the applicator.

Limitations on aerial application do exist and should be recognized. These include weather hazards, fixed obstacles, field size and shape, the distance from the point of application to the landing area, and the danger of contamination of nearby areas due to drift or misapplication. Perhaps the greatest single limiting factor is the pilot himself. A competent and effective performance by the pilot returns many benefits. Haphazard or careless applications can be harmful to the crop, the grower and the applicator, and are beneficial to no-one.

The AT-401B is a 400 gallon workhorse powered by the Pratt & Whitney R-1340 radial engine. It incorporates all the rugged durability, safety features, and flying ease that Air Tractors are known for with the low price tag of a piston engine plane.

Loading a crop duster with grass seed to be used for erosion control in the city of Los Alamos, NM after the Cerro Grande Fire. *USDA photo by: Bob Nichols*

NASA's Langley Research Center performed a number of wake vortex studies at its Wallops Island facility. A crop duster was flown low and slow over a red smoke flare. As the wing tip passed over the smoke generator, the vortex created a turbulent flow that can cause control problems to following aircraft. *Image: NASA*

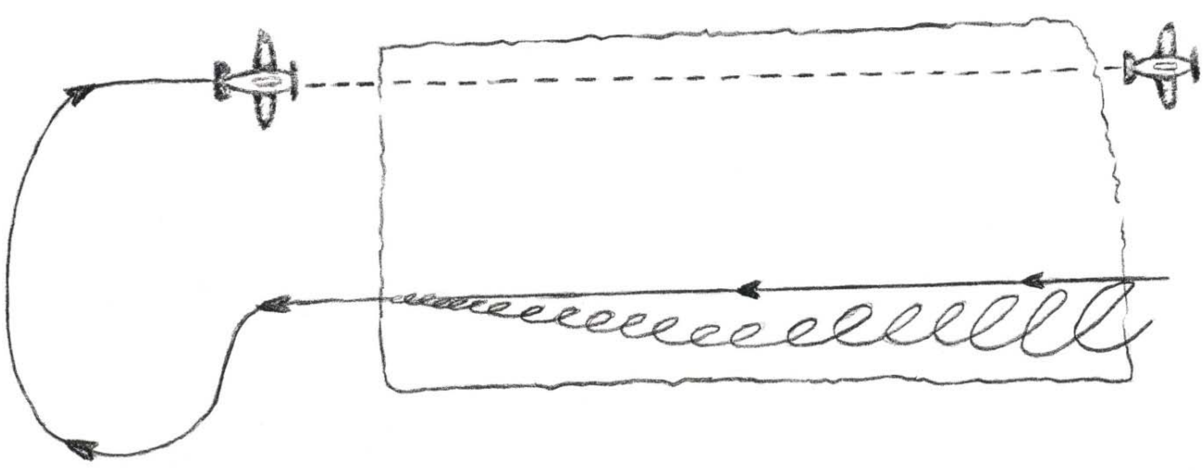
Aircraft Sprayers

Fixed-wing Description
Fixed-wing aircraft with spray booms mounted below the lower wing have been used effectively to apply herbicidal sprays over extensive areas to control brush and weeds since the 1950s. Today's spray planes are designed specifically for aerial application of liquid and dry materials and meet strict safety requirements. They use radial-piston or turbine engines with a range in horsepower from 600 to 1300. Current spray tank capacities vary from 400 to 800 gallons while older aircraft had spray tank capacities of 300 gallons or less.

Airspeed can vary from 100 to 160 mph but is about 120 mph for brush and weed spraying. Spray boom length should not be more than three-fourths the length of the wingspan because the turbulent wingtip vortices cause drift. Spray pumps must have positive shut-off valves and nozzles must have check-valves to prevent continuous spraying or leakage over off-target areas. Hydraulic spray nozzles are the predominate type used on aircraft and many styles and sizes are available. GPS/GIS systems are helpful for precision applications.

When using an approved pesticide the objective is to distribute the correct dose to a defined target with the minimum of wastage due to drift using the most appropriate spraying equipment. Acceptable spray distribution is relatively easy to achieve with most ground-based directed spraying, but spray application with fixed and rotary wing aircraft presents more complex problems. The purpose of this section is to identify some of the problems and to suggest means of addressing them. Although the number of aircraft licensed for aerial spraying has decreased recently, where large uniform areas have to be rapidly treated, aircraft application is usually considered to be more fuel-efficient than ground spraying. Aircraft are used to apply both liquid and solid materials as well as to broadcast seed when soil conditions prohibit the use of ground equipment. The regulations and any State or federal laws relating to aircraft spraying must always be observed.

Field Flight Patterns
With rectangular fields, the normal procedure is to fly back and forth across the field in parallel lines. Flight directions should be parallel to the long axis of the field because the number of turns are reduced. Where cross-winds occur, treatment should start on the downwind side of the field to save the pilot flying through the previous swath, as shown in the diagram below.

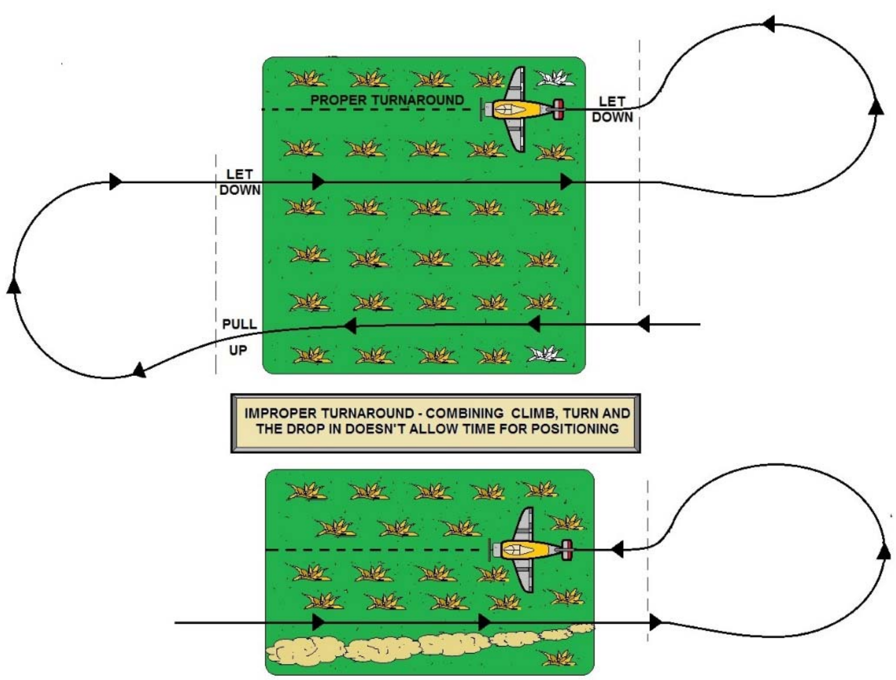


When this fits in with crop rows, the pilot can line up the aircraft with a crop row. If the area is too rugged or steep for these patterns, flight lines should follow along the contours of the slopes. Where spot areas are too steep for contour work (mountainous terrain), make all treatments down slope. Avoid flying parallel to a stream or large lake if there is a tendency for drift toward the stream or lake.

Swath Marking
Swaths can be marked with flags set above the height of the crop to guide the pilot. This method is useful if the field is going to be treated several times in a season. Two flagmen can be used to aid the pilot to line up across the field. When the pilot has lined up on his swath, the nearer flagman starts pacing off (or counting crop rows) to the next swath. Flagmen should avoid being directly sprayed on and they should ***NEVER*** turn their backs toward an oncoming aircraft.

Federal orders prohibit using youths under 16 years of age as flagmen. Where the aircraft is flown parallel to a row crop, one flagman can be used to identify the swath row to the pilot. Automatic flagmen (a swath marking device) are in common use now. These devices, attached to the aircraft and controlled by the pilot, release weighted streamers. These streamers give the pilot a visible mark to help him judge the next swath. Permanent markers in the fields are also in common use.

Turnaround
At the end of each swath the pilot should stop the disseminator and pull up out of the field before beginning his turn. The turn should be completed before dropping into the field again. He should fly far enough beyond the field for his turn to permit slight course corrections before dropping into the field again for the next swath, as shown in the following diagram.



PESTICIDE APPLICATION
(FIELD FLIGHT PATTERN & PROPER TURN AROUND)

Obstructions

If obstructions occur (trees, power and telephone lines or buildings) at the beginning or end of the swath, it is preferable to turn the equipment on late or shut if off early. Then, when the field is completed, fly one or two swaths crosswise (parallel to the obstruction) to finish out the field.

Do not run the disseminator when dropping in or pulling out of the field, since the pattern will be distorted. Obstructions inside the field should be treated in the same way. Skip the treatment as you avoid the obstruction, then, at the finish, come back and spot treat the skipped part, flying at right angles to the rest of the job.

Areas adjacent to buildings, residences and livestock should be treated with extra care. Try to fly parallel to the property line, leaving a border of untreated crop to avoid possible drift onto unwanted areas. Adjust pullout and drop-in paths and avoid making turns over houses. Use caution when fields include or are adjacent to waterways, canals, or reservoirs. Treat fields with care if sensitive crops are planted next to them.

Be certain that beekeepers are warned if they have beehives near the field to be treated and you are applying chemicals harmful to bees.

These guidelines have been prepared to offer practical help to all those involved in applying pesticides by air for food and fiber production and apply equally for vector control in public health programs. The potential for high productivity and safe aircraft deployment can only be realized when the spray operation is well organized and the people involved are fully trained and aware of their responsibilities.

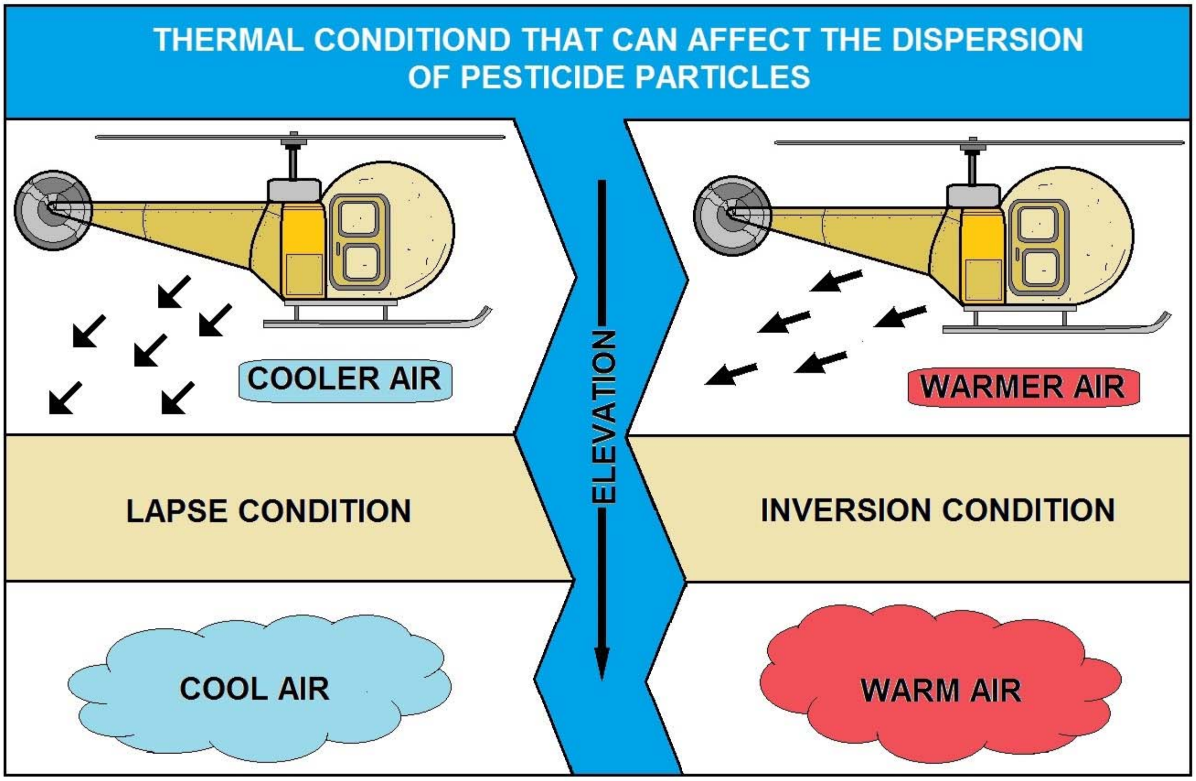
Aerial spraying can be used to treat large areas quickly and, unlike ground spraying, can be carried out when field conditions prevent wheeled vehicle access, which enables the timing of spray treatments to be improved and soil compaction reduced. There are however, certain disadvantages associated with aircraft spraying. High wind speed and temperature inversion may limit treatment application whilst trees, waterways, environmental considerations and overhead power lines may also prevent some fields from being treated. Accurate deposition in dense crop canopies can also be more difficult to achieve with aircraft. Volatility and spray drift can be a problem with aerial spraying and environmental contamination can be significant if spraying is incorrectly executed.

Federal and state codes for pesticide use and application, and FAA regulations are already in place, this course is offered as additional guidance. The importance of referring to the existing legislation cannot be over emphasized, as the failure to comply may have legal implications if a product complaint arises or an off-target contamination incident occurs.

Helicopters

Helicopters with boom sprayers are well suited for use in mountainous areas, steep terrain, highly irregular shaped sites, or remote areas. They are highly maneuverable and apply sprays at much slower speeds than fixed-wing aircraft. Airspeed can vary from 30 to 80 mph, but is about 45 mph for brush and weed spraying.

To maintain precision application rates, aircraft should be equipped with variable-rate, flow-control units to compensate for changes in airspeed. GPS/GIS systems are helpful for precision applications. Spray tanks vary in size from 90 to 230 gallons, and the spray boom should not exceed 90% of the rotor diameter. Many types and sizes of nozzles are available.



THERMAL CONDITIONS EFFECT ON PESTICIDE APPLICATION

Aerial Application

The conditions and regulations outlined in the fixed-wing aircraft section also apply to helicopters. Applications must follow the chemical's Product Label, and the applicator must be certified by the state. Batch trucks which carry clean water and chemical mixing tanks for helicopters usually have landing pads atop the truck for convenience and safety in servicing. Ground personnel must always be alert to the helicopter's moving rotors during servicing.

Helicopters are more expensive to operate than fixed-wing aircraft, but they have the advantage of operating where fixed-wing aircraft cannot. Helicopters do not need landing strips and are adapted to remote rugged terrain and irregular shaped sites. GPS/GIS units negate the need for flagmen in these remote sites and can record flight patterns.

Agricultural Aircraft Equipment Section

Equipment for aerial pesticide application is limited to either fixed or rotary wing aircraft. Regardless of the choice, there are at least a few general features which should be considered.

These are as follows:

1. **Pilot's fresh air supply**--Filtered air for the pilot to breathe is necessary because it is nearly impossible for the pilot to avoid flying back through some of the swath of previous flight passes. If a filtered-air helmet is not available, the pilot should at least wear an approved respirator.
2. **Fuselage features**--Enclosed fuselages should be fitted with cleanout panels for the regular removal of corrosive sprays and dusts. Spray pumps, filters, and control valves should be easily accessible for maintenance and repair.
3. **Maintenance**--The seasonal use of agricultural aircraft might suggest a pattern of inspection and repair during the idle, off-season periods. However, the critical demands of agricultural flying call for all the regular maintenance checks at all required intervals to ensure that the aircraft is in first class order at all times.

Two of the more important advantages of fixed wing aircraft are a high speed of application and a large payload capacity per dollar invested. Maneuverability is adequate, though not equal to the rotary wing aircraft. One of the limitations of fixed wing equipment is the necessity of a designated landing area, which may not always be in close proximity to the application area.

Rotary wing aircraft offers the advantages of extreme maneuverability and speed variation, and may be operated in almost any local area. Pilots of these crafts must also be competent, alert, and have knowledge of the area and the limitations of their crafts. Rotary wing flying puts a special demand on the pilot to perform application with minimum time loss in turns, hovering and loading, since this type aircraft is more expensive to operate per unit of flying time than fixed wing aircraft.

The 500 gallon AT-502 series has been the most popular Air Tractor model, with over 400 planes sold. As with all Air Tractors, it is designed and manufactured to assure operators of a high level of productivity and low maintenance.

Section Objectives
The following guidelines have been drawn up to cover the application of both conventional aqueous undiluted sprays and ultra-low volume (ULV) formulations. They provide information and advice on safe practices.

For adequate aerial spray operation the following considerations must be addressed:
a) Close co-operation between the grower, the spray contractor and the pilot.
b) Adequate pre-planning before spraying.
c) Awareness and understanding of local environmental considerations.
d) Consideration of the safety of people, animals and non-target crops.
e) Accurate selection of approved products.
f) Use of appropriate spray technology and well maintained equipment.
g) Competent and well trained management and support staff.
h) Pilot awareness.

Application
Spraying equipment and techniques are designed to minimize drift while applying spray droplets of efficacious size to the plant canopy. Aerial sprays are normally applied when wind speed is between 2 and 10 mph and air temperatures are not above 90^{O} F.

Spraying should not be conducted in no-wind conditions because of inversions (warm air over cold air) or potential shifts in wind direction. Federal (EPA) and state regulatory agencies have strict regulations for aerial spraying, and applications must follow the specifications on the chemical's Product Label. Fixed-wing aircraft are cost effective because they can spray large areas quickly and effectively. They have larger payload capacities and greater airspeeds than helicopters. Airstrips are required for landing, servicing, and takeoff.

Excessive ferrying distances are wasteful and costly. GPS/GIS units negate the use of flagmen and can record flight patterns. Fixed-wing planes are not suited for spraying highly irregular shaped sites or mountainous areas.

Many over-the-counter pesticides for household and garden use are sold in a form ready for application. Solid products are often spread simply by sprinkling from the boxes in which they are furnished, and some liquid products can be sprayed from simple, small pressurized equipment.

Several pesticides used for vector control are available in granular forms that can be applied by hand or through commonly available equipment like fertilizer spreaders or horn seeders. Other pesticides used in vector control require specialized equipment for their application.

Some public health pesticides come in concentrated form and must be diluted to produce what is known as a tank mix. Mosquito adulticides that are applied as fogs or by using ultra-low volume techniques require equipment designed for these purposes. Because the labels of the pesticides used in these kinds of applications carry specific restrictions on droplet size and application rates, it is critical that the equipment be maintained in good working order, and that the equipment is calibrated frequently to make sure the applications conform to label requirements.

The first question that needs to be asked when choosing the type of pesticide application equipment to be used in vector control operations is whether a liquid or a solid (dust or pellets) pesticide formulation will be used. For liquid formulations, the basic choice will hinge on the spray techniques to be used.

Spray techniques, in turn, often are classified on the basis of the spray volume used in an application. The three basic types of liquid spray techniques are high volume (40 gallons per acre or more), low volume (0.5–40) gallons per acre), and ultra-low volume (0.5 gallons per acre or less).

Training for Pilots and Ground Support Staff

Adherence to local requirements must be the starting point for all those involved in aerial spray application. Training is required for ground support staff as well as for the pilot. The local FAA Aviation Authority will normally administer the pilot's flying license and a permit to apply pesticides, however, additional training in the techniques of spraying is usually required to qualify for agricultural work. Whilst a private pilot's license can usually be obtained locally, training for agricultural work may have to be undertaken elsewhere at a recognized training facility.

A pilot must prove competence in the use of pesticides related to:
a) Appropriateness of the pesticide and formulation
b) The correct dose rate, application technique and procedures
c) Awareness of the hazards associated with the use of the product
d) First aid procedures in the event of an accident

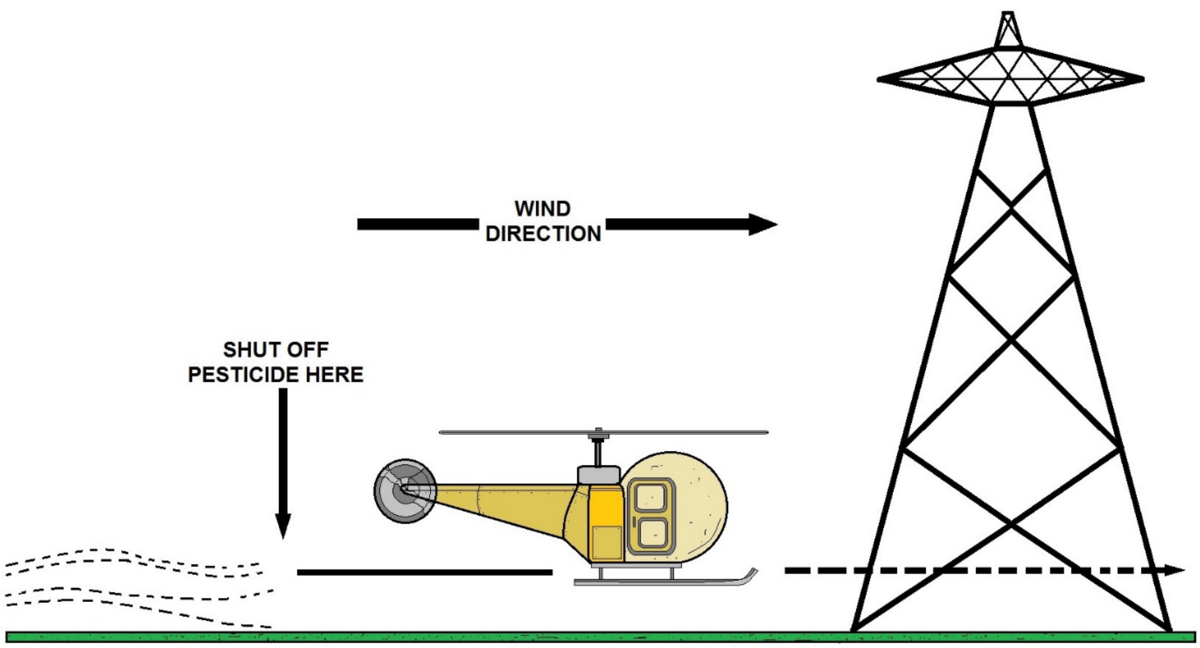
In some states spray contractors work to agreed company guidelines which are regularly checked and updated by the FAA Aviation, EPA and /or other authorities, who issue applicator, worker or handler licenses and register individual spray aircraft as airworthy and compliant with the specifications for spray operation.

Ground support staff (mixers, loaders and flagmen) must be adequately trained to ensure that they are fully protected and the spray operation is as safe as possible. Ground-based functions cover two distinct operations:
a) Mixers and loaders.
b) Crop Advisors, Workers Handlers, and flagmen.
a) The mixer/loaders.

These staff must be fully conversant with their company procedures, operating manuals and practices so that products are safely mixed and loaded into the aircraft hopper in the correct amounts at the recommended dilutions.

Protecting the mixer/loader is a high priority as exposure potential is high when handling concentrated pesticides. Where many aircraft sorties are flown from each airstrip this results in extended periods of exposure of the ground crews and increased risk. Engineering controls such as closed chemical transfer devices, returnable containers and pre-measured chemical dose packs should be used to reduce the risk to ground staff.

Training must therefore cover the safe and correct use of chemical loading and transfer systems and the use of personal protective equipment (PPE).



PESTICIDE APPLICATION
(Adjusting for specific conditions: wind - objects - drift distance)

Personal Safety Section

Pilot

Pilots should never be involved in loading aircraft with pesticides. It is difficult, even with normal protective clothing and equipment, to load without some exposure. Accumulated exposures may bring on mild pesticide symptoms, including dizziness and fixed contraction of the pupils (miosis) of the eye.

The latter symptom has been reported to have diminished visual acuity, especially at night. While these mild symptoms may not be serious to ground applicators, or the ground crew, they are potentially fatal to a pilot, especially in a night application. If pilots are exposed when dispensing pesticides and also during loading operations, this may accumulate enough dosage to trigger symptoms. When crosswinds occur, application should start on the downwind side of the field to avoid flying through the previous swath.

There is evidence that accidental direct eye contamination by organophosphates may cause contraction of the pupils from 7-10 days without any other symptoms. There have been several reports of fatally injured agricultural pilots who were using organophosphates and who had definite miosis discovered following the crash.

While it is very difficult to assign "*pilot error*" crashes to pesticide exposure, present evidence suggests pesticide exposure should be kept to a minimum. Where symptoms characteristic of pesticide poisoning occur, the pilot should not fly until they are gone.

Remember, your body will tolerate small amounts of most pesticides. You can accumulate doses of pesticide from various operations--flying, loading mixing, cleaning, etc., but when you reach a certain level, symptoms will begin.

There have been a number of air crashes where the pilot was drenched with pesticide from a ruptured spray tank. Many pesticides are rapidly absorbed through the skin in addition to entry through the respiratory route. It is essential that contaminated clothing be removed as soon as possible and the pilot "*streak*" for the nearest water for washing--ditch, creek, pond, hose, etc. This is not the time for modesty.

The California Department of Health has reported one pilot who was not critically injured in a crash but was splashed with TEPP and Phosdrin and died of organophosphate poisoning 20 minutes later. Similar poisonings can also occur with Paraquat or Parathion.

Chemical Spill

A filter or canister type respirator appropriate for the chemical being applied should be used. If one is needed for extended periods during hot weather, use a respirator and crash-helmet combination that is ventilated with fresh air.

Flagman

It is essential that the flagman wear adequate protective clothing when exposed to pesticides. Pilots should not spray or dust over flagmen. Permanent markers are being used in increasing amounts by aerial applicators. These markers eliminate the possibility of exposure by flagmen.

Loading Crew
The handling of very toxic pesticides, sometimes in concentrated forms, necessitates the wearing of proper protective clothing. Puddles of pesticide spilled in the mixing or loading area can penetrate improper footwear. Only liquid-proof or rubber boots should be worn.

Aerial Application Check List
It is suggested that pilots and crew, including flagmen, review a check list at least weekly. It is easy to become complacent and careless.

Pilot Check List: The pilot should do the following ***BEFORE, DURING*** and ***AFTER*** any application:

1. The pilot should not load or handle highly toxic pesticides during any operation, especially hazardous formulations.
2. Engines should be shut off during loading operations.
3. Hard helmets with pesticide respirators should be worn in flight.
4. Check the field and surrounding area prior to application and make sure there are no animals, humans, crops, waterways, streams and ponds that would be injured or contaminated either from direct application or drift.
5. Do not fly through the drift of an application.
6. Stop treatments if winds rise and create a drift hazard.
7. Do not turn on dispersal equipment or check the flow rate except in the area to be treated.
8. Refuse to fly if the customer does not read and understand the flagman check list. Also refuse if he insists on having pesticide applied in a manner and time which may create a hazard to crops, humans, animals, and surrounding environment.
9. Read the label yourself and know the hazardous characteristics of the pesticide.
10. Know how far and in what direction the chemical will drift.
11. Do not spray or dust over flagmen.
12. After completing the job, do not dump remnants on the field but carry them to the loading area and have the crew dispose of remnants in a safe manner.

Ground Crew Check List

The ground crew should do the following ***BEFORE, DURING*** and ***AFTER*** any application. Also, the ground crew should be familiar with the pilot's check list.

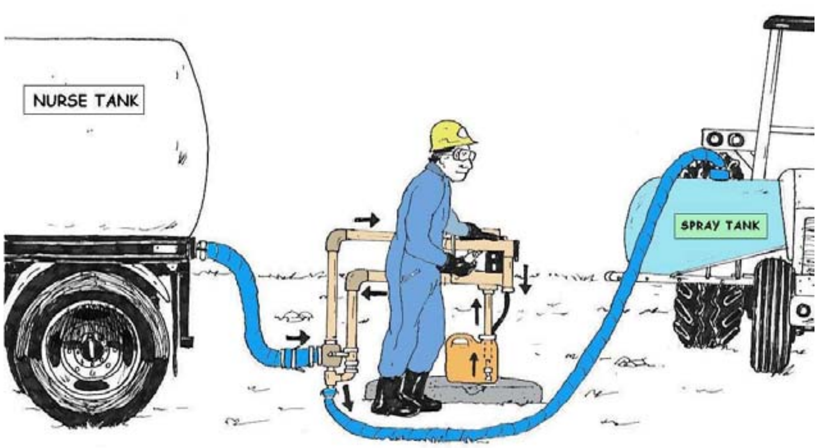
1. The aircraft, especially the cockpit, should be cleaned frequently.
2. Tanks and hoppers should be tightly sealed so chemicals will not blow back over pilot.
3. Cover the hopper as soon as loading is completed.
4. Remove any chemical spilled near the fill opening.
5. When cleaning aircraft or other equipment, use extreme care and wear protective clothing.
6. Do not stand in or allow runoff water to splash on you.

Change clothing after washing aircraft and contaminated equipment.

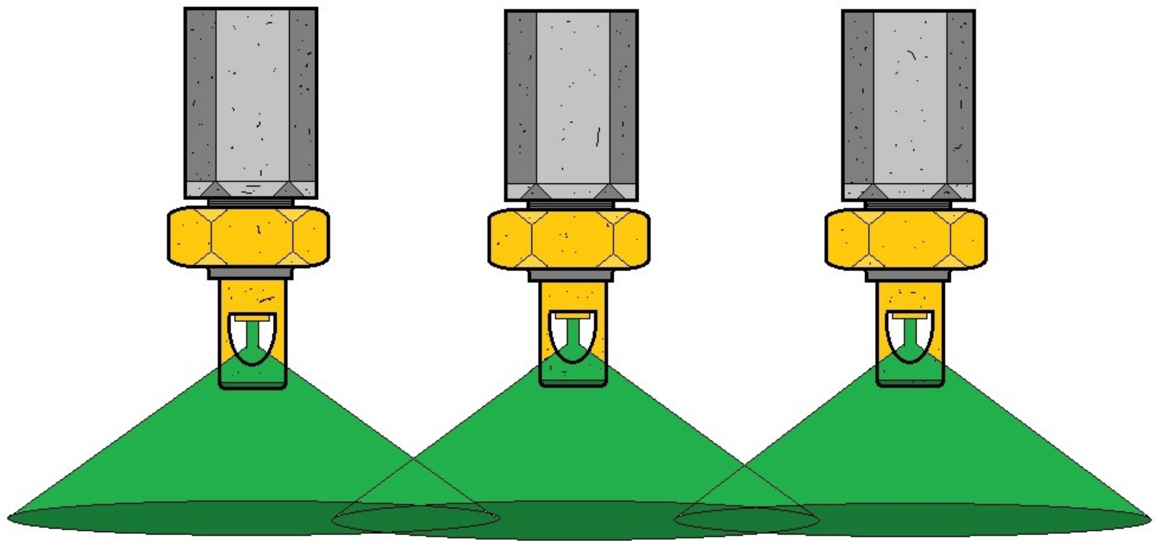
Flagman Check List

Where flagmen are used, they should do the following ***BEFORE, DURING*** and ***AFTER*** any application. A flagman should also be familiar with the pilot's check list. If the farmer is to assist the flagman, be sure he is familiar with this check list.

1. When the flagman arrives at the field to be treated, he should warn all people in the immediate area that an aircraft is going to treat a certain area. Ask these people to stay out of the area and avoid drift.
2. Avoid as much spray or dust as possible.
3. Wear the appropriate protective equipment for the pesticide being applied.
4. As soon as the aircraft is lined up with you for a pass, move over to the next position, but ***DO NOT TURN YOUR BACK ON AN APPROACHING AIRPLANE***.
5. Stay at the field until the pilot has completed the job. If there is an accident, you may be able to help the pilot.
6. Carry a card or have printed on the work order, a copy of which you should have, the chemical being applied and any emergency instructions for the doctor in case someone is exposed to a toxic dose of the chemical.
7. Have a radio-equipped vehicle nearby so that you may contact your office for changes in instructions or emergency procedures.



Never allow a stand-in to perform your job without a thorough knowledge of this check list and the job he is to do.



FLAT FAN NOZZLE WITH PROPER PATTERN OVERLAP
(Pesticide Application)

Crop Advisors, Workers Handlers, and Flagmen

Crop Advisors, Workers Handlers, and flagmen are responsible for meeting legal requirements for operational safety as well as for issuing warnings to those likely to be effected by the spray operation such as local beekeepers, and those adjacent to the area to be sprayed. Before spraying, the Crop Advisors, Workers Handlers, and will visit the site to be treated, noting obstacles such as trees, overhead power-lines, waterways, roads and houses which may be flown over during the spraying.

Frequently an additional requirement of ground staff is to provide the link between the spray contractor and members of the general public.

The use of a Global Positioning Satellite (GPS) system for aircraft navigation is strongly recommended as a safer alternative to the use of human flagmen however, where human flagmen are used, they should be:

- ✓ able to select and use appropriate personal protective equipment;
- ✓ aware of the need to avoid contamination by working upwind from the flight path;
- ✓ aware that records of the pesticides used during the day must be readily available (e.g. for use in cases of intoxication of the worker or his family);
- ✓ able to communicate with the pilot and the staff at the loading area in the event of a change in the weather that might effect the spray operation. N.B. weather conditions at the airstrip may be very different from those at the site to be sprayed;
- ✓ appropriately trained and in possession of a recognized certificate of competence, which should be regularly updated.

Trainers, with specialist knowledge and understanding of aerial spraying, should be used to train ground crews.

Spray Equipment Selection
The selection and use of appropriate spray equipment plays an essential role in safe and efficient pesticide use. In order to obtain a license, aircraft have to be checked by the FAA, however, spray equipment must also be approved. Much of the spray equipment is common to that which is used on terrestrial equipment, however, where aircraft are to be used for applying undiluted formulations (ULV), the sprayer system and components should be made from materials which are compatible with such formulations. Where reduced liquid flow rates for ULV spraying are used, a spray monitoring system and a flow meter are essential.

The FAA, in collaboration with the Department of Agriculture or other designated institution, should verify the spray system. This should include checks on the spray system, calibration and spray distribution to ensure that all valves, anti-drip devices, and spray nozzles are working satisfactorily. The accuracy of calibration of spray monitoring systems should also be checked.

Dispersal Accessories
Metering and dispersal are key functions of all pesticide-applying aircraft. Metering must be accurate for calibration and for the uniform, controlled delivery of liquids and solid material.

Liquid dispersal systems consist of a hydraulic circuit including pump, tank, hose, boom, filters, regulators and metering nozzles. These systems may be wind-driven or directly powered from the aircraft engine.

The pump system must deliver large quantities of liquid material per unit of time. This often means that maximum output is available only at high engine RPM. For this reason, certain aircraft must be in flight to develop top delivery.

Pumps and agitators must be designed to handle the desired nozzle output plus approximately 5 P.S.I. for line friction and agitation.

Spray pattern tests should be conducted to determine the optimum location of nozzles along the boom and the spray droplet size categories following initial setup. Spray boom shape should be airfoil or streamline to reduce turbulence around the nozzles. Catalogs from nozzle manufacturers list types and sizes for aircraft. A check valve is necessary on each nozzle to prevent leakage.

Spray nozzles type, size and orientation, operating pressure, and wind shear (aircraft speed) all influence spray droplet size. Small droplet sizes are prone to drift from the application site, so the largest droplet size possible that will maintain the desired efficacy on the targeted plant should be used.

Pressure at the spray nozzle should be between 20 and 60 psi. Research has shown that low spray pressures and high aircraft speed can increase the percentage of spray droplets that have a propensity to drift. All nozzles produce a range in droplet size particles and manufacturers usually rate their nozzles with a volume median diameter droplet size (DV0.5). The percentage of spray droplets less than 100 micrometer (DV0.1) is an indication of potential drift. Considerable research has been conducted to determine droplet sizes under actual airspeed conditions. ASAE Standards and predictive models are available.

Centrifugal Pumps
Fairly low pressure (35 to 45 P.S.I.) high volume centrifugal pumps may be used for water based materials. Shear, or air friction across the nozzle opening, serves to provide material break-up. Bi-fluid or microbial sprays call for special pumps.

Standard, dilute volume spray equipment which has a range of 1/2 to 5 gallons per acre or more must have adequate piping. The main piping and fittings should have an inside diameter of at least 1-1/2" in order to carry heavy volumes of liquid. For rates of 1/2 to 2 gallons per acre, all piping should have at least a 1" diameter.

Filter screens at the nozzles and line filters protect nozzles and other parts from wear and clogging. Screen sizes of 50 to 100 mesh will be used, depending on nozzle orifice size. Pressure gauges located beyond the line filter indicate whether the line is clogged or opened. Line filters should be cleaned daily during spray operations.

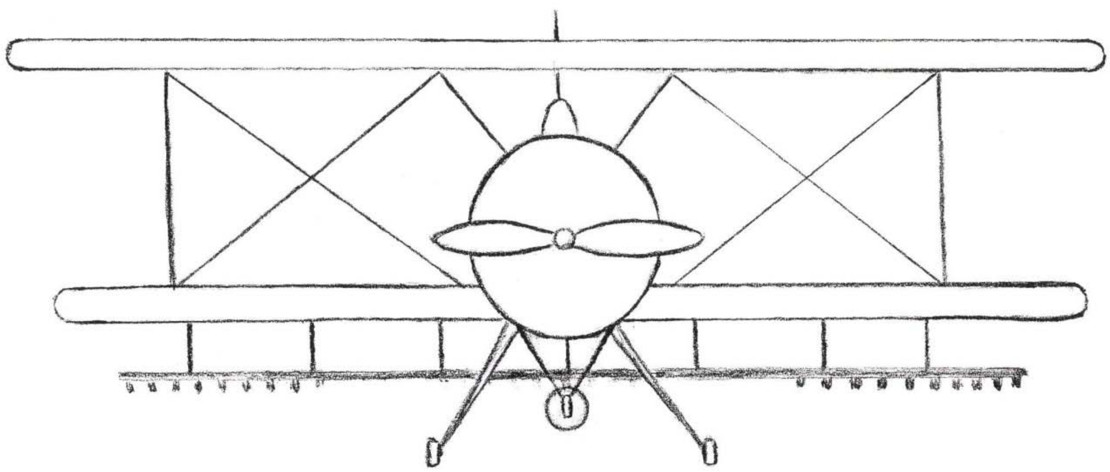
Ultra Low Volume
Ultra Low Volume (**ULV**) equipment ranges in capacity from a few ounces to 1/2 gallon per acre. Special metering and atomizing attachments such as Micronair, Mini-spin and Airfoil are frequently used to aid in droplet break-up. These spiral, rotating nozzles may be wind driven or driven from the aircraft. Wind driven nozzles are dependent upon air speed and may fail when the craft is operating at reduced speed.

Ultra Low Volume systems use a 3/8" inside diameter for the main line, hoses and fittings. Hoses for intermediate nozzles may be 1/8" inside diameter. The use of concentrate sprays (no water added) increases the density of the material and allows a faster rate of all.

This process is limited to certain materials and is subject to a drift hazard. Flying heights of 5 to 15 feet above ground contribute to uniformity.

Booms

Booms are required to support nozzles along the wingspan of the craft. Booms must be strong, airfoil shaped and located near the trailing edge of the wing to offer minimum drag. Clearance between the control surfaces of the wing and the boom is essential. End caps on booms should be removable for cleaning. The location of outboard nozzles on the end of the boom is critical, since the wing end and main rotor vortex are used to develop the width of the pattern. End nozzles must be inboard enough to prevent wing tip vortexes from trapping fine droplets. Such entrapment creates uneven distribution and drift. Propeller rotation shifts the spray from right to left as the pilot sees it. Nozzles need shifting to the right with respect to the fuselage to compensate for this. Ultra Low Volume systems require supply lines to the metering spinners only. Usually no boom is needed.



Spray Boom Calibration

1. Use chart for distance to drive in the field. Use nozzle spacing for booms. For directed and band rigs use the row spacing.
2. Set throttle for spraying and operate all equipment. Note seconds required to drive measured distance.
3. Catch spray for the noted time in Step 2 in container marked in ounces. If boom, catch spray from one nozzle during noted time. On directed rigs, catch spray from all nozzles per row for noted time.
4. Nozzle or nozzle group output in ounces = gallons/acre actually applied.
5. Repeat for each nozzle to assure uniform distribution. Replace any nozzles whose output is greater than 10 % of the average of all nozzles.

Row Width or Nozzle Spacing (in.)	Distance (ft.)	Row Width or Nozzle Spacing (in.)	Distance (ft.)
40	102	26	157
38	107	24	170
36	113	22	185
34	120	20	204
32	127	18	227
30	136	16	255
28	146	14	291

Nozzles

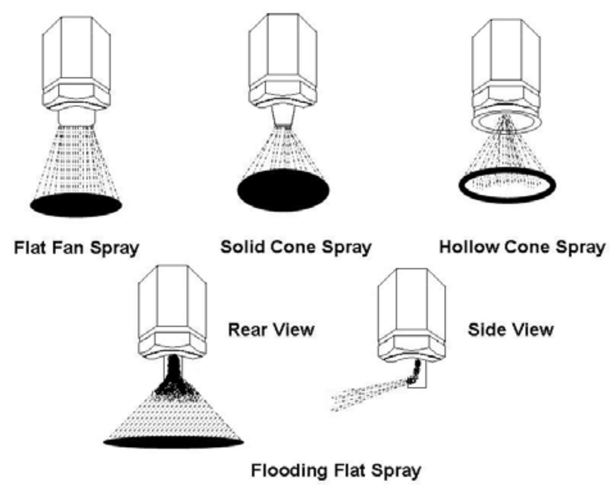
A variety of materials are used to make nozzles, including brass, stainless steel, ceramic and nylon. There are advantages and disadvantages with each type of material. However, it is wisest to invest in the best quality nozzles available. Brass nozzles are relatively inexpensive, but they wear rapidly with abrasive materials, such as wettable powders and liquid fertilizers. Stainless steel and hardened stainless steel are the most resistant to wear, but their expense discourages some users. Frequent replacement of brass nozzles usually makes their use more costly in relation to the area sprayed. The smooth surface of nylon nozzles makes them relatively resistant to wear, but the threads are easily damaged in use, especially when over tightened.

Modified nylon tips in metal housings avoid some of these problems. However, some solvents react with nylon, causing the material to swell and become unusable. Ceramic spray nozzles are also abrasion resistant, but are expensive and breakable. There are different types of spray patterns produced by nozzles each designed for a specific application.

Choosing the proper nozzle for a particular treatment will ensure good coverage and minimum drift. The selection of a nozzle is determined by the type of treatment being applied as well as certain aspects of the spray equipment such as flow rate and operating pressure. Herbicides are applied at low pressure to produce large droplets that reduce drift.

Higher pressures are used with fungicides to produce small droplets for better coverage of foliage. Insecticides are applied with pressure ranges between these two extremes. Drift control adjuvants work best with nozzles that reduce the number of fine and mist-like drops. To be effective and safe, nozzles may need to be changed for different pesticide applications.

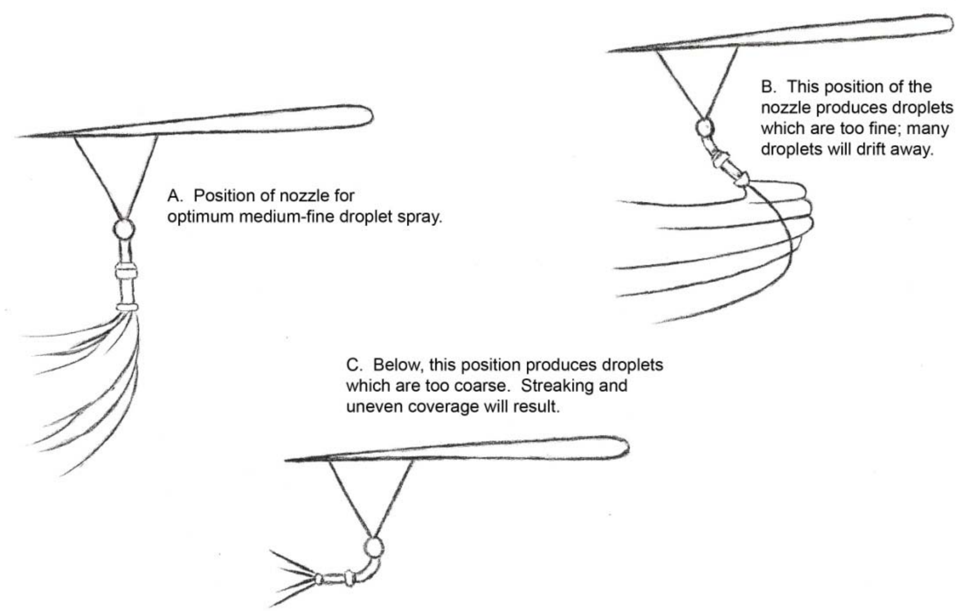
Nozzle Section
Nozzles are a critical part of aircraft spray equipment. Their selection, location, calibration and testing are essential factors. The selection of nozzles is based on manufacturers' recommendations. Care must be exercised not to limit line pressure below 30 to 45 P.S.I. for water solutions. Special nozzles which entrain air or mix fluids in the tips are available. These are classified as foaming and bi-fluid systems. Nozzles for handling emulsions and slurries must have larger orifices.



Droplet Size
Droplet size is greatly affected by nozzle orientation on the boom. More shear and liquid break-up may be obtained by orienting nozzles with the direction of flight. A swivel action is desirable.

Nozzle types, in order of break-up or particle size, are: (1) fine--hollow cone; (2) intermediate--flat fan; (3) coarse--solid cone. Droplet size may also be controlled by the type of mixture being used (example: water emulsion or chemical wetting agent, etc.).

Other influencing factors are the density, viscosity and surface tension of the liquid, and the evaporative conditions in the air between the point of release from the aircraft and the point of impingement on the ground.



For safety and economic considerations, positive shut-off control is essential. This may be attained through the use of diaphragm or ball check valves or a suction return control. Diaphragm nozzles are considered more efficient. All types require maintenance to ensure proper performance.

Rotary Spray Systems
Spray systems for rotary wing aircraft include tanks mounted on the side of the frame in line with the rotor shaft. A common cross pipe feeds the engine-driven pump. Filter, regulator and control valves are attached to the lower frame of the fuselage in view of the pilot. Boom and nozzles may be mounted on the rotor, frame, or toe of the skids, enabling the pilot to see them.

Using Pesticides Correctly
Product selection should be made taking into consideration the environmental risk, the potential applicator, worker or handler exposure hazard and the recommended dose rates. The products chosen must be used strictly in accordance with the label specification.

The majority of pesticide products and formulations approved for conventional aerial spraying are similar to products applied through conventional ground sprayers, however, when applied by air they are generally used at lower water volumes and therefore at higher spray solution concentrations. Where products used are not designed for aerial application, some formulations can present problems such as thickening, excessive foaming and emulsion inversion.

Chemicals are often used for control of invasive weeds and brush that hamper revegetation efforts on rangelands. Agricultural herbicides undergo extensive toxicological, environmental, plant efficacy, and cost-benefit tests before being released for widespread use. This database of knowledge enables the applicator to select herbicides to fit the targeted weeds and brush for maximum efficacy, efficiency, safety, and economics.

The number of herbicides for use on rangeland has changed little in the past two decades, and it appears that there will be little change in the next 20 years. The major change in application practice has been a shift from broad-scale aerial applications to individual plant treatments with ground equipment. In either case, the application equipment has been designed for more precision and safer use. Global positioning systems (GPS) and geographic information systems (GIS) on aircraft or ground units allow the applicator, worker or handler to "sculpt" the landscape for multiple land-uses, e.g. wildlife habitat, grazing, water harvesting, and aesthetics.

Herbicides will continue to play a significant role both singly and in combination with fire and mechanical treatments in revegetation projects. Persons applying restricted-use pesticides must have state certified Applicator's License and follow specifications on the chemical's Product Label. It is important to note that the Directions for Use section of all pesticide product labels begin with the statement: "It is a violation of Federal law to use this product in a manner inconsistent with its labeling."

Granular Dispersal Systems
Granular dispersal systems are used for applying dust, impregnated granules, fertilizers and seed. A hopper with agitation must be provided to prevent bridging of fine material. Fine materials less than 60 mesh require agitators to prevent bridging. Frequent inspection of metering gates is required to ensure against leakage common under flight conditions of low pressure. The metering gate is the means of calibration. Size, shape, density and flowability of material all affect the swath width, application rate and pattern. The use of granular systems is on the decline in agricultural work.

Distance between Nozzle and Target (Boom Height)
Less distance between the droplet release point and the target will reduce spray drift. Less distance means less time to travel from nozzle to target and therefore less drift occurs.

Herbicide Volatility
All herbicides can drift as spray droplets, but some herbicides are sufficiently volatile to cause plant injury from drift of vapor (fumes). For example, 2,4-D or MCPA esters may produce damaging vapors, while 2,4-D or MCPA amines are essentially non-volatile and can drift only as droplets or dry particles.

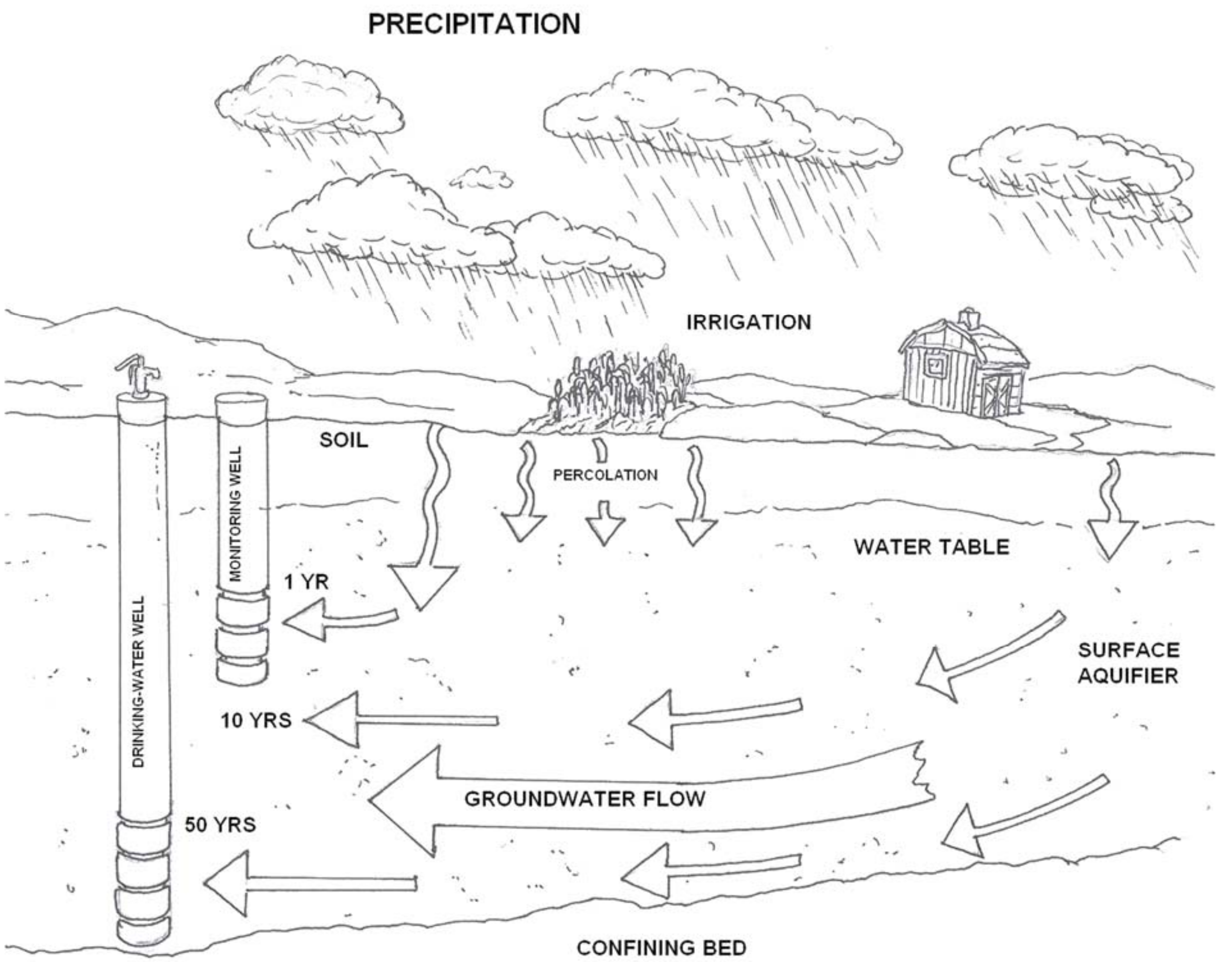
Relative Humidity and Temperature
Low relative humidity and/or high temperature will cause more rapid evaporation of spray droplets between the spray nozzle and the target than will high relative humidity and/or low temperature. Evaporation reduces droplet size, which in turn increases the potential drift of spray droplets.

Wind Direction and Velocity
Herbicides should not be applied when the wind is blowing toward an adjoining susceptible crop or a crop in a vulnerable stage of growth. The amount of herbicide lost from the target area and the distance the herbicide moves will increase as wind velocity increases, so greater wind velocity generally will cause more drift. However, severe crop injury from drift can occur with low wind velocities, especially under conditions that result in vertically stable air.

Over the past several decades the greatest and most widespread uses of herbicides have been in the production of row-crops and forages and in the clearing of brush for pasture improvement.

Oversight and carelessness in the use of herbicides on these crops and pastures have often resulted in unwarranted crop damage and substantial economic loss to growers or users of herbicides. This is especially true where small scale, high-value crops of sensitive nature are involved.

Sometimes farmers and landowners unknowingly apply hazardous herbicides in such close proximity or under such unfavorable climatic conditions that they injure their own crops or those of their neighbors.



Herbicide Hazards

Whether there is herbicide injury to crops depends upon several factors:

- the chemical nature of the herbicide,
- the sensitivity of the plant species,
- the methods of application,
- the proximity of target and non-target crops, and
- the behavior of the herbicide in the environment.

All herbicides can be classified as either selective or nonselective. Selective herbicides kill certain weeds with little or no injury to the crop. It is the difference in plant response that determines the effectiveness of the herbicide and safety to the crop.

Non-selective herbicides are those which will kill or injure virtually all kinds of vegetation. The risk of drift is great when the application is by foliar spray. When the soil is treated, a hazard may arise from the herbicide persisting in the soil longer than intended and interfering with growing a crop at some later time. The movement of a non-selective herbicide by runoff or by soil erosion to non-target areas is another possibility. Typical 2,4 D injury symptoms on grape leaves.

Drift hazards
There are two ways herbicides drift to non-target areas.

1. Mist droplets are generated by the sprayer nozzles. The size of droplet depends upon the nozzle pressure, the size of nozzle orifice and the surface tension of the spray solution.

2. Vapor may be generated depending upon the volatility of the herbicide. The amount of vapor varies with the chemical and the conditions of application.

Droplet Drift
The distance of droplet drift depends upon the size of the droplets, the velocity of the wind and the height above the ground where the herbicide is discharged. In general, larger orifices and lower pressures result in larger droplets. Conversely, the smaller the orifice and the greater the pressure, the smaller will be the size of the droplets. The smaller the droplet, the farther it will drift with wind of any particular velocity.

Vapor Drift
Volatility refers to the ability of a herbicide to vaporize and to mix freely with the air. Volatile herbicides may produce vapors that can be carried great distances from the target area to other crop sites. Such herbicide volatility can also reduce the rate of application to the target area. A row of grapevines severely injured by herbicides used to clear the nearby railroad.

Phenoxy Herbicides
The phenoxy group of herbicides has been most often involved in crop injury by off-target drift. The phenoxy group includes 2,4-D, 2,4,5-T, 2,4-DB, 2,4,5-TP (Silvex) and MCPA. These herbicides are most commonly used for the control of broad-leaved weeds in crops and for the control of undesirable woody species.

Phenoxy herbicides are more or less volatile. Vapors can arise from the herbicide while mixing, during and after application.

Phenoxy herbicides in general are formulated in two ways, as esters or amines. Esters are more effective in controlling hard-to-kill weeds but are the most hazardous in terms of volatility and consequent drift to sensitive crops.

There are two categories of esters: the regular form and the low-volatile form. The latter form is less likely to cause problems. The amine formulations are safer to use than are the esters, but they are less effective in their performance.

Susceptible Crops
Although most kinds of broad-leaved plants are susceptible to injury by phenoxy herbicides, grapes and tomatoes are the most sensitive. Cotton, soybeans, potatoes, other vegetables, legume crops and many ornamental trees, shrubs and flowers can also be severely affected.

Because grapes are one of the crops most sensitive to phenoxy herbicides, these herbicides should not be applied in an area where vineyards are established. Great distances between the site of application and the location of a vineyard, tomato field, melon patch or greenhouse may not afford protection against injury from drift.

Problems of drift are common and often result in hardship for the grower of the susceptible crop, judgments against the applicator for crop losses and a bad reputation for the herbicide. Typical leaf-curl symptoms of soybeans exposed to phenoxy herbicides.

Symptoms of Injury
Mere traces of a phenoxy herbicide may cause sensitive plants to produce abnormally large leaves, exaggerated distances between leaves and multiplied or enlarged flowering or fruiting parts.

Greater concentrations of the herbicide can cause stunting and cupping of leaves, spiraling growth of soft shoots, clearing and enlargement of major leaf veins and severe distortion of flowering or fruiting parts. After severe exposure, leaves may be fan-shaped or severely stunted and curled, with extensive development of small teeth along leaf margins.

When grapes are visibly affected, there will generally be uneven or delayed coloring of the fruit. Reduced production of sugars within the fruit can render the crop worthless. Shoots grow either excessively long or may be stunted, and the canes may lose their ability to survive normal winter temperatures. Leaves exhibit the characteristic fan shape with sawtooth margins.

Affected tomato plants exhibit cupped or elongated leaves with enlarged pale veins and toothy margins. Stem twisting, severe stunting of plants, puffy fruits or abortion of flowers commonly occur.

Soybeans usually exhibit leaf distortion at lowest levels of exposure while higher levels can result in yellowing of foliage and defoliation.

Greenhouse crops, vegetables, ornamental plants and desirable native vegetation are affected in various ways. The leaves and stems of shrubs or trees may become stunted, stretched, twisted or spindly to the extent of being unsightly or worthless.

Long-term Effects
Woody plants such as grapes, apples and peaches which show substantial stem and leaf distortion usually fail to produce a marketable crop. If the symptoms are sudden or severe, one to three years may be required for recovery. Severe cases of phenoxy herbicide injury may result in stunted growth and poor ripening for two to four years after exposure. Growers seeking monetary compensation should be aware of these long-term effects and not be too quick to settle damage claims.

Annual crops of herbaceous plants such as florist crops, field crops and vegetables do not have the same potential for long-term losses. But the value of a single season's crop can constitute a major economic loss to either the grower or the user of the herbicide.

Other Herbicides
Several herbicides other than the phenoxys can also injure sensitive crops. Some of those applied to soils to control woody plants or weeds in crops may be absorbed by the extensive roots of nearby plants such as fruit trees, nut trees and grape vines. Certain non-phenoxy herbicides used to kill woody plants by application to the foliage can cause problems when they drift to economic crops.

Preventing Crop Injury
Awareness is the key to preventing damage by phenoxy and other herbicides. Once applicators are aware of the hazards and possible consequences of misuse they can take several steps to prevent problems:

- ✓ Learn the locations of sensitive crops in the area.
- ✓ Avoid use of ester formulations of phenoxy herbicides in any area near sensitive crops.
- ✓ Use amine forms of phenoxy herbicides to reduce the risk of vapor drifting to nearby sensitive crops.
- ✓ Apply pesticides, especially herbicides, on a calm day or when a light breeze is blowing away from sensitive crops.
- ✓ Spray when temperatures will remain below 90 degrees F to prevent or reduce vaporization.
- ✓ Use sprayer nozzles with larger orifices and operate at lower pump pressures to reduce the production of fine droplets.

Resolving Problems
User responsibility. Registration and labeling of a particular pesticide clearly give individuals the right to apply the pesticide as long as they follow the directions for use and the precautions stated on the label. The use of a pesticide in any way contrary to the label is a violation of federal law. Misuse of a pesticide may make the user liable to either criminal prosecution or to civil proceedings or both.

Although there is no legal obligation for herbicide applicators to take stock of sensitive crops in the area of application and to consult and cooperate with neighbors in matters of herbicide use, it is advisable to do so.

Further information about pesticide use and hazards can be obtained from any University of Missouri Extension Center. Rights of injured parties. Those who grow specialty crops which may be injured as a result of pesticide misuse have rights protected by law. Through civil proceedings, injured parties may attempt to regain financial losses or to secure punitive judgments.

Growers of sensitive crops are not obligated to inform operators of surrounding farms and local industries of the presence and sensitivity of their crops, but it is advisable to seek the cooperation of neighbors in the use of hazardous pesticides. Reporting incidents of pesticide damage. Two governmental agencies may exercise regulatory powers in situations of herbicide misuse.

Spray Pressure
Spray pressure influences the size of droplets formed from the spray solution. The spray solution emerges from the nozzle in a sheet, and droplets form at the edge of the sheet. Increased nozzle pressure causes the sheet to be thinner, and this thinner sheet will break into smaller droplets than from a sheet produced at lower pressure. Also, larger orifice nozzles with high delivery rates produce a thicker sheet of spray solution and larger droplets than smaller nozzles.

Communication
The majority of drift complaints pertain to trees, shrubs and ornamentals. Communicating with non-agricultural rural residents may reduce complaint submissions originating from lack of knowledge of products used and injury symptoms.

Other Components
Flow control devices are necessary to make the tank, pump and nozzles work together. Depending on the application system, these devices may include pressure regulators, unloader valves and control valves. Because both the spray pattern and flow rate are determined by operating pressure, each sprayer should be equipped with a pressure gauge. The gauge should be placed where it may be easily seen. Strainers are also required for effective treatments. Strainers trap particles and debris in the spray mixture and protect the pump, control devices and nozzles from damage.

Dispersal Summary
All nozzles produce a range of droplet sizes. The small, drift-prone particles cannot be eliminated but can be reduced and kept within reasonable limits.

Here are some tips:

- Select low or nonvolatile pesticides.
- Read and follow the pesticide label. Instructions on the pesticide label are given to ensure the safe and effective use of pesticides with minimal risk to the environment. Each pesticide is registered for use on specific sites or locations. Surveys indicate approximately 65 percent of drift complaints involved application procedures in violation of the label.
- Apply a pesticide only if economic thresholds warrant an application.
- Use spray additives within label guidelines. This will increase the droplet sizes and pesticide effectiveness.
- Use larger orifice sizes. This will give larger droplets and will increase the number of tank refills, but will improve coverage and effectiveness.
- Avoid high pressure. High pressure creates finer droplets; 45 PSI should be considered maximum for conventional broadcast spraying.

- Use drift-reduction nozzles. They will produce larger droplets when operated at low pressures.
- Use wide angle nozzles, low boom heights, and keep the boom stable.
- Drift is minimal when wind velocity is less than 10 mph. Do not spray when wind is greater or blowing towards sensitive crops, gardens, dwellings, and livestock or water sources.
- Use shielded booms. When banding, use shroud covers.

Pesticide applicators and others, including landowners, play a very important role in pesticide application -- deciding whether or not to apply a pesticide and if so how best to make that application. It is their responsibility to know and understand a product's use restrictions.

They are responsible for complying with all other pesticide laws regarding pesticide applications and ensuring that their application equipment and techniques will produce a minimum of spray drift. The EPA also expects applicators to exercise a high level of professionalism in making decisions about applications.

Drift Control Explained

The EPA defines spray or dust drift as:
"the physical movement of pesticide droplets or particles through the air at the time of pesticide application or soon thereafter from the target site to any non- or off-target site. Spray drift shall not include movement of pesticides to non- or off-target sites caused by erosion, migration, volatility, or windblown soil particles that occurs after application or application of fumigants unless specifically addressed on the product label with respect to drift control requirements."

This definition is based on a definition of spray drift composed by participants of the National Coalition on Drift Minimization, which include representatives from federal (including the EPA and the U. S. Department of Agriculture) and state agencies and tribes, pesticide and equipment manufacturers, university scientists, and others, who have focused their attention on enhancing pesticide applicator education, application research, and regulatory initiatives to foster reductions in spray drift.

The Agency recognizes that pesticide vapor and the off-target movement of pesticides by other means, not included in this definition, can nevertheless present substantial risks to humans and the environment. The EPA generally addresses these routes of exposure and associated risk at the individual pesticide level through its regulatory programs.

In addition to the safety problems associated with the preparation and application of pesticides, there are several important problems related to pesticide use that should be understood by every applicator. These problems include pesticide drift, pesticide residues, phytotoxicity, destruction of beneficial species of animals and plants, resistance of pests to pesticides, and environmental pollution. There are many ways in which these undesirable effects can be reduced or eliminated. Each depends upon knowledge of the proper handling and use of pesticides, the components of the environment susceptible to contamination, the pesticides most likely to cause contamination, and preventive measures.

Except for ultra low volume (ULV) spraying to control adult mosquitoes, drift is an undesirable side effect associated with both aerial and ground pesticide applications. Spray drift is defined as airborne particles produced during application of a pesticide moving outside the intended treatment area. The severity of drift depends on the physical form of the material, the method of application, weather conditions, and to a lesser degree, movement of the substrate to which the product was applied (both soil and water).

Drift is a desirable and necessary part of an ULV application. In fact, pesticide labels specify that ULV applications must be done during weather conditions that favor pesticide drift (temperature inversion or lateral winds below 10 MPH). In a ULV application, the longer the effective drift of the product, the greater the efficacy.

For other pesticide applications, the formulation of the pesticide is a significant factor. Dusts are most likely to drift and granules least likely. High pressure sprayers are more likely to produce fine droplets that are more likely to drift than low pressure sprays. A variety of other factors can affect the amount of drift. When spraying liquid formulations of pesticides, the nozzle and pump pressure have the greatest influence on subsequent drift. Improper or worn nozzles or excessive pressures cause the spray to be produced in a form which drifts readily.

The rate at which a drop of liquid falls through the air depends upon the size of the droplet. Very small droplets fall very slowly. These small droplets can drift for miles before they reach the ground. The method and amount of material applied also influences the hazard of pesticide drift. Small amounts applied by hand from the ground are rarely involved in drift problems. Spray from ground air blast sprayers is highly subject to drift. Aerial applications of large quantities of pesticides always present the possibility of significant drift.

A second form of drift occurs when pesticides evaporate during and after application. Certain herbicide formulations may volatilize and cause damage to plants miles from the point of application. A few herbicide formulations may drift as a result of evaporation following application; use of these may be restricted in many areas.

Drift should be avoided because:

- It wastes resources, including pesticides, fuel, and technician time.
- It spreads pesticides into the surrounding environment where they may become illegal residues on food crops, cause health problems, damage wildlife, and have other undesirable effects.
- It can damage sensitive crops.
- It has been the subject of many damage claims for crop losses. Drift can be a severe problem and should be taken into consideration before making any type of pesticide application

What Is Pesticide Spray Drift?

The EPA defines pesticide spray drift as the physical movement of a pesticide through air at the time of application or soon thereafter, to any site other than that intended for application (often referred to as off target). The EPA does not include in its definition the movement of pesticides to off-target sites caused by erosion, migration, volatility, or contaminated soil particles that are windblown after application, unless specifically addressed on a pesticide product label with respect to drift-control requirements.

How Does Spray Drift Occur?

When pesticide solutions are sprayed by ground spray equipment or aircraft, droplets are produced by the nozzles of the equipment. Many of these droplets can be so small that they stay suspended in air and are carried by air currents until they contact a surface or drop to the ground. A number of factors influence drift, including weather conditions, topography, the crop or area being sprayed, application equipment and methods, and decisions by the applicator.

What Are the Impacts of Spray Drift?
Off-target spray can affect human health and the environment. For example, spray drift can result in pesticide exposures to farmworkers, children playing outside, and wildlife and its habitat. Drift can also contaminate a home garden or another farmer's crops, causing illegal pesticide residues and/or plant damage. The proximity of individuals and sensitive sites to the pesticide application, the amounts of pesticide drift, and toxicity of the pesticide are important factors in determining the potential impacts from drift.

Whenever a pesticide chemical is applied, some of the chemical becomes a deposit on or in the treated crop, animal or object. The pesticide may remain in its original chemical form or it may be altered chemically by weathering, metabolic degradation or other processes. In any case, the quantity of material remaining is called a residue. Residues may result from direct application, from drift from nearby fields, from uptake from contaminated soil, or from other sources. In some situations residues are desirable and produce prolonged effective pest control, as in the control of certain public health and structural pests. In other situations, however, residues represent a source of unwanted and illegal contamination — for example, when residues exceed legally determined limits on food or feed crops at harvest.

Pesticide Residues
Pesticide residues are generally meant to include pesticides that are detectible in or on places other than their intended target. Fresh water reservoirs, stream bed sediments, and harvested food would be examples of places that would be tested for pesticide residues. Needless to say, if high levels of residues were found to occur in such situations, few would consider the test results to be a good thing. Pesticide residues are usually measured and tolerances expressed in parts per million (ppm) to parts per billion (ppb) on a weight basis.

One ppm is one milligram in a kilogram, or one ounce of salt in 62,500 pounds of sugar, or one pound of pesticide in one million pounds of raw agricultural commodity. In some instances modern analytical chemistry techniques can test residue levels below one ppb.

The residue levels allowed on food crops at harvest are legally set by the federal and state regulatory agencies and are called tolerances. Tolerances are simply the maximum amounts of pesticide permitted to be present on or in raw agricultural commodities. These tolerances represent levels of pesticide residues which scientists have determined may safely remain on the food crop without injury to the consumer. Tolerances vary according to the pesticide and the crop.

When pesticide tolerances are found to be exceed legal tolerances, the agricultural commodities involved may be seized and destroyed. Ordinarily, such situations would arise from the application of agricultural pesticides on crops, but it could happen even where pesticide applications are not specifically targeted at a crop pest, such as the application of pesticides on rice fields for mosquito control.

Before allowing the use of a pesticide on food crops, EPA sets a tolerance. If no tolerance has been set for that pesticide on that crop, the pesticide cannot be legally applied on the crop. Some pesticides may be considered "safe" by EPA, and they would be exempted from a tolerance.

How Does the EPA View Off-Target Spray Drift?
The EPA recognizes the importance of exposures to pesticides resulting from spray drift. There are thousands of reported complaints of off-target spray drift each year.

Reports of exposures of people, plants, and animals to pesticides due to off-target drift (often referred to as "*drift incidents*") are an important component in the scientific evaluation and regulation of the uses of pesticides. Other routes of pesticide exposure include consuming foods and drinking water which may contain pesticide residues, applying pesticides, and contacting treated surfaces in agricultural, industrial, or residential settings. The EPA considers all of these routes of exposure in regulating the use of pesticides.

Off-Target Drift

When labels of pesticide products state that off-target drift is to be avoided or prohibited, our policy is straightforward: pesticide drift from the target site is to be prevented. However, we recognize that some degree of drift of spray particles will occur from nearly all applications.

Nevertheless, applicators and other responsible parties must use all available application practices designed to prevent drift that will otherwise occur. In making their decisions about pesticide applications prudent and responsible applicators must consider all factors, including wind speed, direction, and other weather conditions; application equipment; the proximity of people and sensitive areas; and product label directions.

A prudent and responsible applicator must refrain from application under conditions that are inconsistent with the goal of drift prevention, or are prohibited by the label requirements. The EPA uses its discretion to pursue violations based on the unique facts and circumstances of each drift situation.

How Does EPA Help Protect People and the Environment from Off-Target Spray Drift?

The EPA is responsible for a number of important programs that help protect people and the environment from potential adverse effects that can be related to off-target drift from pesticide applications. These programs include restricting how pesticides are used, certification and training of applicators, and enforcement and compliance of pesticide laws.

Adjuvants

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.

Restricting How Pesticides are Used
Under Federal law, the EPA's Office of Pesticide Programs is responsible for evaluating pesticides and their uses to ensure that they can be used with a reasonable certainty of no harm to human health and not cause unreasonable risks to the environment when properly applied.

In fulfilling these duties, the EPA considers the potential impact of spray drift on humans and the environment in our evaluations of proposed pesticides for new registration and older, existing pesticides for re-registration. As a part of the EPA's evaluation of a pesticide, the EPA estimates the amounts of off-target drift and the associated potential risks to human health and the environment.

Restrictions on a pesticide's application may be triggered in two ways. For new pesticides and existing pesticides undergoing re-registration, estimated deposition levels are evaluated along with the pesticide's toxicity. For existing pesticides, available information on drift incidents is also evaluated. Based on these evaluations, the OPP may impose specific restrictions for a pesticide's application.

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.

Other Federal Laws and Regulations
In addition to the Federal Insecticide, Fungicide, and Rodenticide Act and the Federal Food, Drug, and Cosmetic Act, a number of other federal laws regulate the use, storage, disposal and transportation of pesticides. The Occupational Safety and Health Act mandates that employers, including farmers and ranchers, protect their employees from hazards in the work place. With respect to pesticides, the law covers workers in pesticide manufacturing plants and also farmworkers applying pesticides to crops.

Hazard communication standards developed by the Occupational Safety and Health Administration require employers to have a written hazard communication plan, possess a safety data sheet (SDS) for each hazardous chemical, and provide training for employees on protective measures. A SDS must contain detailed information on the chemical, its hazards, and procedures to be followed in the event of an emergency.

Pesticide use is regulated by several federal laws designed to protect the environment. The Federal Endangered Species Act makes it unlawful to harm any plant or animal listed by the Fish and Wildlife Service (FWS) as *endangered* or *threatened*. The EPA, in cooperation with the USDA and the FWS, developed an Endangered Species Protection Program to protect listed species from harmful effects of pesticides. Under the program, pesticide use is restricted in areas where endangered species are likely to be exposed.

Product labels instruct users to consult county bulletins specifying locations within the county where use of the products is restricted. The Clean Water Act protects the nation's waterways from both point and non-point sources of pollution. Discharges of waste products (point source pollution) are controlled by the EPA through a permit system. Amendments to the Clean Water Act in 1987 allow for restrictions on non-point source pollutants, such as runoff of agricultural chemicals. The EPA is presently requiring states to submit management plans for the control of nonpoint source pollution. Pesticides in drinking water falls under the jurisdiction of the Safe Drinking Water Act. This law authorizes the EPA to set maximum contaminant levels for pesticides in drinking water.

Enclosed Cabs

Enclosed cabs must have a nonporous barrier that totally surrounds the occupants and prevents contact with pesticides outside of the cab. Enclosed cabs that provide respiratory protection must have a properly functioning ventilation system that is used and maintained according to the manufacturer's written operating instructions. The cab must be declared in writing by the manufacturer or by a governmental agency to provide at least as much respiratory protection as the type of respirator listed on the pesticide labeling.

Examples:
Some enclosed-cab systems provide respiratory protection equivalent to a dust/mist filtering respirator and could, therefore, be used as a substitute when that type of respirator is specified on the product labeling. Other enclosed-cab systems are equipped to remove organic vapors as well as dusts and mists and could be used as a substitute when either the dust/mist filtering respirator or an organic-vapor-removing respirator is specified on the product labeling.

1. Enclosed cabs that do not provide respiratory protection — In an enclosed cab that does not provide respiratory protection, handlers need not wear all the PPE listed on the pesticide labeling, but must wear at least:
• long-sleeved shirt and long pants,
• shoes and socks, and
• any respirator required for the handling task.

2. Enclosed cabs that provide respiratory protection — In an enclosed cab that provides respiratory protection equal to the labeling-required respirator, handlers need not wear all the PPE listed on the pesticide labeling, but must wear at least:
• long-sleeved shirt and long pants, and
• shoes and socks.

3. In any enclosed cab where reduced PPE is worn — Handlers must:
• keep immediately available all PPE listed on the labeling for the type of task being performed,
• store the PPE in a chemical resistant container (such as a plastic bag),
• wear the PPE if it is necessary to leave the cab and contact pesticide-treated surfaces in the treated area, and
• take off PPE that was worn in the treated area before reentering the cab in order to prevent contamination of the inside of the cab.

Note: If the PPE that was worn in the treated area needs to be stored inside the enclosed cab, it must be stored in such a way that will prevent contaminating the inside of the cab. One way to achieve this would be to store the contaminated PPE in a chemical-resistant container, such as a plastic bag.

Cockpits

1. Gloves when entering or leaving an aircraft — Handlers have the option of whether to wear chemical-resistant gloves when entering or leaving an aircraft used to apply pesticides, *unless* the pesticide product labeling requires chemical-resistant gloves to be worn for these activities. If gloves are worn for such a use, then if they are brought inside the cockpit, handlers must store the used gloves in a enclosed container, such as a plastic bag, to prevent contamination of the inside of the cockpit.

2. Open cockpits — In an open cockpit, handlers must wear any gloves, respirator, and body protection listed on the pesticide labeling for application tasks. However, they may wear:
• shoes and socks instead of chemical-resistant footwear,
• a helmet instead of a chemical-resistant hat or hood, and
• a visor instead of protective eyewear.

3. Enclosed cockpits — In an enclosed cockpit, handlers need not wear all the PPE listed on the pesticide labeling, but must wear at least:
• long-sleeved shirt and long pants, and
• ***shoes and socks.***

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.

Specific Restrictions
Specific restrictions may include prohibiting the use of certain pesticides under certain conditions, prohibiting certain methods of application, requiring use of a foliage barrier, or requiring a buffer zone distance between the site of application and areas to be protected.

In general, applicators must use all available drift prevention practices in order to prevent drift. During the past few years, the OPP has received and reviewed new studies on spray drift that it required from pesticide registrants to support their product registrations. The OPP has completed its review of these studies and reached conclusions about the factors that influence drift and the amounts of sprays which can drift from the application site.

U.S. Department of Agriculture

The OPP also collaborated under a cooperative research and development agreement with registrants and the U.S. Department of Agriculture (USDA) on the development of a model ("*AgDRIFT*") to predict distances of spray drift under many different conditions.

To ensure the scientific quality of the conduct of the studies, the conclusions that were drawn from these studies, and the predictive model, the OPP obtained independent expert peer reviews, including the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), Science Advisory Panel.

These expert peer reviews supported the use of the model and these studies for the OPP's science assessments of pesticides. Based on these studies and reviews, the OPP is now developing improved product labeling to inform applicators of requirements to control off-target spray drift. The OPP plans to publish these requirements and an implementation plan in a draft notice (PR Notice) this winter and ask for public comments.

Where Can Complaints About Spray Drift Be Directed?

If you believe that you have been exposed to pesticide spray drift and have health-related questions, you should contact your physician, local poison control center, or health department for assistance. You can also contact the National Pesticide Information Center.

Integrated Pest Management

IPM offers growers an array of tools to help manage pest problems. At the foundation of this approach are good growing practices, preventive pest management measures, and a regular pest monitoring program that enables producers to accurately determine if a pest control measure is economically justified. IPM uses a common sense approach to find the weak link in a pest’s life cycle.

Sound pest programs do not attempt to eradicate pests, but rather to manage them so that economic crop losses are minimized. IPM is the primary BMP for pest management.

It involves combining practices such as:

- Selecting crops and varieties which are resistant to pest pressures.
- Timing planting and harvest dates to minimize pest damage.
- Rotating crops.
- Monitoring pest and natural enemy populations.
- Employing beneficial insects and other biological controls.

The philosophy behind the IPM approach is to create unfavorable conditions for pest buildup by enhancing crop vigor and by protecting natural enemies that aid in controlling pest populations.

IPM relies on a combination of practices to reduce damage by insects and related pests. Crop rotation and resistant varieties can be used to avoid some pest problems. Identifying pests promptly allows necessary and effective treatments to be applied before pest populations reach damaging levels. Treating a pest problem with either synthetic or natural pesticides is only a temporary solution. If a pest is recurring from year to year, then a new management strategy should be developed. As usually practiced, IPM includes judicious use of chemical pesticides applied only after scouting reveals pests at economically damaging threshold levels.

Scouting
An IPM program depends on good scouting. The scout walks through the field and inspects plants for insects at least once a week, sometimes more frequently when weather and season favor rapid pest buildups. Scouting for pests can prevent damage by identifying problems early, and it can save money if fewer treatments are needed (see Grower Example 1.)

Scouts target specific insects and select search techniques accordingly. Grasshoppers, for example, appear first on field edges, spider mites next to harvested small grains, and armyworms next to wheat. Other specific scouting tips are given later in this chapter. As well as looking carefully at a random sample of plants, scouts may use sweep nets to sample highly mobile insects such as potato leafhoppers.

Bean leaf beetles, cucumber beetles, Mexican bean beetles, and stinkbugs will drop onto a ground cloth or 'beat sheet' when the plant is shaken. Bright, adhesive-covered cards placed near plants will trap small, hard-to-see insects such as aphids, thrips, and whiteflies. Aphids and whiteflies are attracted to yellow cards and thrips to blue ones.

Grower Example 1
Replacing automatic spray schedules with as-needed treatments based on scouting reports saved 62 percent of a group of Florida vegetable growers an average of $95 per acre. The remaining 38 percent reported costs of monitoring equaled pesticide savings. Thus all growers did at least as well economically as if they had used scheduled pesticide applications and most did better.

For some pests, adult populations are monitored for advance warning of egg-laying and larval stages. This gives the grower time to detect population buildup before damage from the larvae occurs and to schedule any necessary treatments.
Black light traps are used to attract night-flying adults of such species as the European corn borer, corn earworm, armyworm, cabbage looper, hornworm, and some types of beetles.

Adults of many moths, including most of those in the cabbageworm complex, can be lured to traps by manufactured sex signals (pheromones). The pheromones for each species are different and placement of the trap must be correct in terms of height, field location (edge or center) number of lures placed, and type of lure used. Manufacturers will provide these details, but some general guidelines are given below.

Economic Injury Thresholds
Economic injury thresholds are available for some, but not all, pests in the southern states. Economic injury levels given in this chapter are only intended as general guidelines.

Information from cooperative extension agents and the experience of local growers are the best guides.

Insecticide Use

Before any insecticide is used in an IPM program, the presence of damaging levels of a pest insect should be confirmed by scouting. Unnecessary applications of insecticide increase costs, promote development of insecticide resistance, and degrade the environment. Use of insecticides sometimes increases the numbers of non-target pests.

On potatoes, for example, carbaryl (Sevin) application has produced peak green peach aphid populations that were more than ten times greater than those in untreated plots. The main factor in this population increase was direct stimulation of aphid reproduction by the carbaryl.

Total nitrogen content, which has been shown to increase aphid populations, also increased slightly, but predator and parasite populations were not affected by carbaryl.

Once the need for an insecticide is confirmed, it should be applied as efficiently as possible. In the middle of hot, dry days, insects are less active and less likely to come in contact with the insecticide. It will also be difficult to get good coverage of wilted plants, and heat will volatilize some insecticides before they reach the plant.

Using the most appropriate sprayer will also increase efficiency as only chemicals deposited on plant surfaces kill insects. For aphids and other underleaf insects, only spray deposited on leaf undersides is effective. Conventional sprayers rely on gravity and inertia to deliver pesticides. By some estimates, only half the pesticide applied adheres to the plant.

Persistence of a Chemical

Most organochlorine pesticides (e.g., DDT, chlordane) are very persistent. Most of the organophosphates (e.g., parathion, malathion) and pyrethroids are much less persistent. Pyrethrins, and carbamate pesticides are nonpersistent. Some factors that influence the persistence of a chemical and the possibility that residues may remain are:

- ✓ The amount of chemical applied
- ✓ The formulation
- ✓ The pH (acidity or alkalinity) of the water diluent and of the target tissue, soil, or water.
- ✓ The nature of the surface to which it is applied.
- ✓ Exposure to weathering from wind, rain, etc.
- ✓ Chemical breakdown from high temperatures and humidity
- ✓ Photochemical reactions from sunlight
- ✓ Biological reactions.

If public health pesticides are applied properly and in accordance with label restrictions for applications around food crops residues on or in the crop should never be a problem.

Organic Agricultural Methods

Organic farming is a form of agriculture which does not permit the use of synthetic fertilizers and pesticides, plant growth regulators, livestock feed additives, and genetically modified organisms. As far as possible, organic farmers rely on crop rotation, green manure, compost, biological pest control, and mechanical cultivation to maintain soil productivity and control pests.

Organic agricultural methods are internationally regulated and legally enforced by many nations, based in large part on the standards set by the International Federation of Organic Agriculture Movements, an international umbrella organization for organic organizations established in 1972. The United States Department of Agriculture also tracks organic policies and procedures nationally.

Vector control technicians working near these farms need work closely with the landowner to prevent vectors from coming from the property, and to avoid jeopardizing the organic status of the crop. If a pesticide excluded for use on organically produced commodities is accidentally applied to an organic crop, the crop may no longer qualify to be sold as organic. If this occurs in connection with a vector control operation, the producer can pursue a settlement from the vector control program for his loss. While that particular harvested crop may no longer be considered organic, the farm will still qualify as "certified organic". If there is repeated contamination by any party, the farm will lose its organic certification and must wait at least 3 years before it may apply for organic certification again.

With the growth of organic farming, vector control operations will face increasing challenges in applying pesticides in the vicinity of organic farms. This will involve developing innovative methods of preventing vector problems from occurring on and adjacent to organic farms while respecting the landowner's desire to maintain organic practices.

Phytotoxic Reaction

Phytotoxicity is the injury or death of a plant due to exposure to a chemical. Plants may be injured or killed by various kinds of chemicals, including salts, fertilizers, or pesticides. Sometimes, plant injury is intentional, as when an herbicide is applied to a weed. In other cases, the plant injury is an accidental side effect of pesticide use. Phytotoxicity can effect any part of a plant, including roots, stems, foliage, blossoms, or fruit.

The degree of phytotoxicity caused by pesticides may vary in response to a number of factors. Some toxicants (active ingredients) are particularly damaging to plants. Other components of the pesticide mixture, such as the diluent, may cause plant damage. The plants themselves may vary in susceptibility to injury by various chemicals. The phytotoxic reaction may vary with the species of plant, with the age of the plant, or with the weather at the time of exposure.

The manner in which a chemical is applied may determine whether or not injury will occur. For example, excessive pump pressures while spraying may cause physical injury to the plant or drive the chemical into the plant tissues. Excessive concentrations of a chemical may cause plant damage. Certain combinations of pesticides may cause phytotoxic reactions.

Some pest problems require two or more chemicals combined in the tank mix. Mixtures are used commonly with great success.

However, some chemicals are not compatible with others and one of the results of this incompatibility may by severe phytotoxicity. Many herbicide labels list other products with which they may be combined.

Electrostatic Sprayers

Electrostatic sprayers which apply an electrical charge to the material being sprayed reduce spraying time and improve insect and disease control per unit of chemical applied.

The charged chemical is attracted to the opposite electric charge on the leaf surface so that retention is better. To further increase efficiency, the charged spray can be delivered with a turbulent air blast, carrying the material deeper into the plant canopy. Such air-assisted electrostatic sprayers deposited four times more spray onto both upper and lower leaf surfaces than conventional mist-blower equipment. Higher amounts of sprays from air-assisted electrostatic units were also found deeper in the crop canopy compared to the amounts delivered by uncharged hydraulic sprayers. These sprayers also deposit more spray on any fruit present in the canopy, however.

Some systemic insecticides are applied to the soil at planting to control early season insects. Thoroughly incorporating granules of these soil-applied chemicals increases control efficiency, while reducing hazards to birds and wildlife from surface granules and granules spilled at the ends of the rows.

Chemical Control in an IPM Program
Regular field scouting, coupled with forecasting pest problems and determining economic thresholds, is used to ensure that pesticides are only applied when pest populations warrant chemical control. The traditional approach of applying pesticides routinely or at the first sign of any crop pest is replaced with a philosophy that seeks to optimize crop growth and allow natural enemies of pests the opportunity to suppress the outbreak.

Producers and consumers must understand, however, that there is no "*silver bullet*" in an IPM program and that some level of pests and diseases must be tolerated. Fortunately, most crops can tolerate a certain level of infestation before significant yield or quality losses occur.

Weeds and Insects
Weedy areas may provide habitat for both pests and beneficial insects, but if plants in adjacent weedy areas are related to crop plants, weedy areas are more likely to be a source of insect pests. Morning glory is related to sweetpotato, for example, and nightshade to tomatoes, potatoes and eggplant. Pests with a wide host range such as armyworms, crickets, cutworms, darkling beetles, flea beetles, grasshoppers, lygus bugs, slugs and snails, stink bugs and thrips often inhabit weedy areas and in some cases will attack nearby crops. Mowing weedy areas for the first time after the crop emerges may encourage migration onto crop plants. It may be best not to mow weedy areas at all or to mow before the crop emerges and regularly after emergence.

Tillage Practices and Insects
Plowing under plant debris to speed up decomposition is a common method to lower pest populations by destroying overwintering stages. Seed corn maggots, for example, survive in decomposing plant material. However, tillage operations will also reduce populations of beneficial insects. A study of field crops showed lower populations of carabid beetles and

spiders in conventionally tilled fields compared to no-till fields. Both of these predators can help control seed and seedling pests. Strip tillage preserves habitat for beneficial insects, while still destroying soil-dwelling insects in the plowed area.

Crop Rotation

Crop rotation is a traditional production practice used to enhance soil fertility and tilt, increase crop vigor, and reduce the buildup of crop pests. Crop rotations cannot solve all weed, insect, and disease problems. However, without rotations, producers are essentially locked into pesticide-based control programs. Rotations are most likely to be effective on pests that tend to be crop specific and overwinter on site. By switching to another crop, pest cycles may be interrupted when they become active and find their food source is gone.

The key to a good rotation plan is to determine which pests are of most concern and then select crops accordingly. Obviously, market factors must be considered for producers to remain profitable. Continuous corn and alfalfa, as well as vegetable only and wheat-fallow cropping systems are common. These systems have some production and marketing advantages, but usually result in weed and other pest problems. Rotating to different crops, such as from vegetables to small grains, provides the additional benefit of scavenging excess soil nitrate.

IPM programs are difficult to implement under cropping systems that do not include rotations. Where rotation is practiced, pesticide use can often be greatly reduced with no significant losses. For example, corn rootworm insecticide is used in the greatest volume of any agricultural insecticide in the United States. Rotating corn fields to any other crop generally eliminates the need for insecticide application, saving money and reducing potential environmental impacts.

Resistant Crop Varieties

Plant breeders have been selecting pest resistant varieties to improve crop productivity for many years. Now, host plant resistance is a cornerstone of many successful IPM programs.

Non-chemical Pest Control Practices

IPM may result in reduced pesticide use by employing preventive pest management and non-chemical pest controls. Non-chemical pest management methods include crop rotation, resistant varieties, cultural practices, and biological controls. These methods are basic to effective IPM and should be the first line of defense. However, producers must plan for their use in advance of pest outbreaks to successfully use non-chemical management tools.

Plants have many natural characteristics for keeping pests at bay: repellent or toxic chemicals, thorns, hairs, and resistant tissues. The greatest plant breeding successes have been in the selection of disease resistant varieties, but insect tolerant lines have also been developed. With some pests, such as plant viruses, the only effective control is the use of resistant varieties and clean planting material. Resistant varieties will not interfere with other pest control measures and may reduce the need for pesticide treatment. However, resistance is not available for all problems. Potential drawbacks include decreased yields, increased susceptibility to other pests, and shifts in predominant pest biotypes as a result of over-exposure to the resistance genes.

Examples of pest resistant crops include Russian wheat aphid tolerant winter wheat, curly top virus resistant sugarbeets, European corn borer resistant corn hybrids, sorghum unpalatable to birds, and dry beans with tolerance to white mold and halo blight.

Other Cultural Practices

Pests have a more difficult time getting established when crop plants are thriving. For example, many late emerging annual weeds cannot compete successfully once the crop canopy shades the row. Insects such as spider mites thrive on drought stressed plants, but are much less competitive on vigorous crops. Producers should employ cultural practices to their advantage.

Optimum plant population, row spacing, fertility, and irrigation are practices that can improve crop vigor, thereby reducing pest competitiveness and impact. Growers should evaluate their production practices for areas where they can enhance crop health and vigor. Usually, these improvements will increase crop yield and economic return. Adjusting planting, tillage, and harvest dates can sometimes help crops avoid pests. Early tillage destroys weeds where some insects lay their eggs. Tillage also is very important for destroying volunteer crops where pests such as Russian wheat aphid or wheat curl mite may overwinter or become established early. Early planting may help the shorter season corn varieties escape economic damage from second generation European corn borer.

Planting too early in the spring or too late in the fall has some drawbacks that producers should consider. Late frost and slowed emergence can make plants more susceptible to disease and insect pressure. A good technique for many growers is to plant a range of maturity dates, beginning as soon as the soil is at the proper temperature for germination.

Producers may want to delay the planting of fields with problem weeds to allow for weed emergence and cultivation prior to crop establishment. Winter wheat growers can avoid wheat streak mosaic and Russian wheat aphid by delaying fall planting.

In some cases, crops can be harvested early instead of spraying. Harvesting alfalfa early may substitute for pesticide in reducing alfalfa weevil populations. An early first cutting can decrease the weevil population by mechanically damaging larvae and exposing them to predation and weather. Early harvesting is also a good way to manage foliar diseases in alfalfa. Harvesting corn for silage or high moisture grain may prevent losses caused by lodging due to stalk rot or corn borer.

Biological Pest Control

Beneficial organisms can help control weeds, diseases, and insects in crop fields when broad spectrum pesticides are avoided. These organisms may occur naturally or may be purposely introduced. Beneficials include predatory insects and mites, parasitic insects, and microbial organisms.

Predators such as lady beetles and green lacewings feed on plant-eating pests. Insect parasites, like the tiny braconid wasp, lay eggs on or inside the developing pest. The single-celled protozoa, Nosema, is a microbial pathogen of grasshoppers. Additionally, grazing animals such as sheep can help control difficult weed species such as leafy spurge. Given favorable conditions, naturally occurring and introduced biological controls can do an excellent job of reducing some pests below economic injury levels.

Due to the cost of introducing biological controls, conserving the natural enemies already in your field is a useful IPM technique. Unfortunately, beneficial insects are often killed when broad spectrum pesticides are applied.

To conserve beneficials in your fields:
Preserve habitat and alternate food sources for beneficials.

- Learn to distinguish beneficial insects from pests.
- Minimize broad spectrum pesticide applications.
- Use selective pesticides that are less toxic to beneficials.
- Treat only those portions of the field where pests cause economic levels of damage.

These natural controls often work more slowly than pesticides, but they can be effective, environmentally friendly, and economically sustainable.

Table 1. Examples of insect biological control organisms released for pest control by the Colorado Department of Agriculture.

Control Organism	Pest Crop
Macrocentrus ancylivorus	Oriental fruit moth Peach
Hippodamia variegata	Russian wheat aphid Wheat
Tetrastichus incertus	Alfalfa weevil Alfalfa
Phrydiuchus tau	Mediterranean sage Range
Ceutorhynchus litura	Canada thistle Range
Rhinocyllus conicus	Musk thistle Range
Calophasia lunula	Toadflax Range
Microlarinus lareynii	Puncturevine Range
Aphthona flava	Leafy spurge Range
Urophora affinis	Knapweed Range

Commercially available biological control organisms are being used successfully by some growers of high value crops. A number of suppliers throughout the United States provide beneficial organisms for release in gardens, greenhouses, and fields. The economic benefit of field releases of beneficial insects is uncertain in many crops because of limited knowledge about when and how to achieve establishment and control.

Biological Pesticides
Biological pesticides, such as *Bacillus thuringiensis* (Bt), are commercially available and are effective against some pests. These products are extremely selective and of low toxicity to humans and non-target organisms. Examples of biological pesticides include bacteria, fungi, viruses, or their toxins.

The bacterial insecticide, Bt, is currently the most commonly used biological pesticide.

Consider using these products in place of more toxic pesticides, especially when water supplies are vulnerable to contamination. Be sure to follow all label directions for application and storage of these products.

Damage to Beneficial Insects
The efficient production of many crops, including fruits, vegetables, forage, and seeds, would not be possible without the activities of honey bees and other pollinating insects. Over the past 100 years or so the honey bee industry has sustained serious losses from pesticide applications. Recently; pesticide poisoning has come under suspicion for reductions in honey bees in the USA. Some agricultural pesticides used currently are known to pose a significant hazard to bees. Vector control applications are ordinarily done in a manner that minimizes risk to bees and other beneficial insects.

In addition to pesticide exposure, honey bee colonies are at risk from a variety of parasites, pathogens, marauding mammals, and other factors. To protect these valuable insects from losses due to pesticide poisoning it is necessary to know where colonies are located before starting a pesticide application, and to protect them in some way. Moving colonies to areas far from the possibility of drift and avoiding the use of pesticides known to be especially toxic to bees are two ways to minimize damage. If public health pesticide applications are planned for areas known to be close to bee colonies, it is also a sound policy to warn hive owners in advance of the applications so they have an opportunity to protect them.

There are other pollinating insects that may suffer damage from pesticide applications, such as alkali bees and other wild bees. Wild bees are not in hives, but are present in a variety of nest types. This complicates their protection from pesticides. Other insects are beneficial because they prey on or parasitize pests. There have been many studies on the effects on non-target organisms of pesticides in a variety of settings. Your local extension specialist can provide you with copies of reports of this kind of research.

By definition, pesticides that harm non-target organism populations significantly are non-selective. If use of a non-selective pesticide is considered essential, it must be justified based on the relative benefits balanced against the relative harm. In the case of public health pesticides, the threat to human health is a necessary consideration.

The ideal pesticide would be selectively nontoxic to bees and other beneficial organisms, while toxic to a specific pest. Few products available for adult mosquito control meet this ideal, but several larval mosquito control products and many herbicides are selective. For adult mosquito control and other pesticide applications, the best compromise must be found.

Honey Bee Protection

For vector control technicians, protecting domestic bees is primarily a concern when doing ULV adult mosquito control. The pesticides most commonly used for these applications (pyrethrins and pyrethroids) are toxic to bees. However, they are applied in minute quantities (often less than 1 ounce per acre of total volume of material) during the evening or early morning when bees are inactive. Taking the reasonable precaution of turning off the sprayer while passing the hives should be adequate to prevent any mortality in the bees from the product.

Bees are readily poisoned by organophosphates and many agricultural pesticides. When a pesticide known to be harmful to bees is used near bee hives or to any cropland where honey bees are working, special procedures must be followed. In some areas centralized private organizations operate a beekeeper notification program. Bee notification maps are maintained and each day copies of beekeepers' requests for notification from the County Agricultural Commissioner are received. Then interested bee keepers are notified by a single telephone call of all intended applications within one mile of their hives.

Pesticide Resistance
Pesticide resistance is the ability of pests to avoid the lethal effects of pesticides. Certain populations of pests use one or more different physiological or behavioral defense mechanisms to withstand doses of pesticides that previously were lethal to the pests. This can happen through spontaneous mutations in populations resulting in genes that confer pesticide resistance, or because a small proportion of the population carries a gene for pesticide

resistance naturally. In either case, resistance develops gradually to the point where pesticide applications begin to fail after repeated exposure to the same pesticide.

This is because the parts of the population that carry the gene for susceptibility are killed off, and soon, a disproportionate segment of the population carrying the gene for resistance predominates. This can be an unintended effect of using pesticides. Resistance in numerous pests of public health importance has occurred to a variety of pesticides. For mosquitoes and flies, resistance to organochlorines and organophosphates has been particularly common.

Selective pressure is the repeated exposure of a population of pests to treatments of the same pesticide over time resulting in a change in the genetic makeup of that population. In this case, the population is selected to favor resistant genes at the expense of susceptible genes, and the population becomes resistant to that pesticide. Because of the nature of population genetics, the population never becomes completely resistant, but the frequency of individuals have susceptible genes becomes very small.

Knowing the mechanisms of development of pesticide resistance is important to developing strategies to avoid creation of resistance in pest populations. The basic principle is the preservation of susceptible genes in pest populations, and the endeavor to do this is named pesticide resistance management.

Usually, when a pest population becomes resistant to one pesticide it can still be controlled by other pesticides, especially pesticides in a different family of chemicals. Occasionally, resistance to pesticides other than the pesticide responsible for resistance may occur. This is called cross-resistance. Its occurrence is usually seen among chemically related pesticides where the mode of action is identical or very similar.

Early Signs of Resistance
Not all pest control failures are the result of resistance. Improper pest control practices may be at fault. However, if the material was timed and applied properly at the recommended rate and no other important factors (such as unfavorable weather) have interfered with the pesticide application, resistance should be considered.

Early signs of resistance may sometimes be recognized in the field. These include increasing difficulty in controlling a pest, increasing numbers of formerly minor pests, and increasing trouble with insect-transmitted disease. Developing resistance can be very subtle and may go unnoticed for a time; it may appear in certain locations or breeding sites. Suspected resistance should be reported to your supervisor immediately since early detection may make it possible to delay resistance by the application of counter measures.

Buffer Zones

A buffer zone is an untreated area wide enough to capture drift fallout adjacent to the sprayed area. Nozzle type, droplet size, product dose, dilution and spray technique should be considered when this unsprayed barrier (buffer) width is determined.

For aircraft spraying the buffer zone needs to be wider than for ground spraying as it is more difficult to make a precise spray cut-off with an aircraft operating at speed. The width of a buffer zone is also influenced by the pesticide product type and by the presence of adjacent waterways.

For example, a buffer zone of 5,000 meters is recommended for certain organochlorine insecticides. This distance is considered adequate to capture sedimenting spray droplets following the completion of a spray run.

Some pesticides are highly toxic to aquatic life so that spray drift fallout over water should be carefully avoided with products with this classification. The product label should provide application details, which should include nozzle selection, volume applied, and application timing. When ULV applications are to be made using rotary atomizers, liquid flow regulation and atomizer rotational speed should also be stated on the label.

The label usually carries first aid information to assist a doctor in the event of accidental contamination. Information on cleaning (“decontamination”) and disposal of empty containers is also usually included on the label.

Tank Mixing
Applying more than one product at the same time (tank-mixing) can improve the logistics and cost of spraying provided the respective treatment timings coincide and the formulations are chemically and physically compatible. Only approved mixtures should be used.

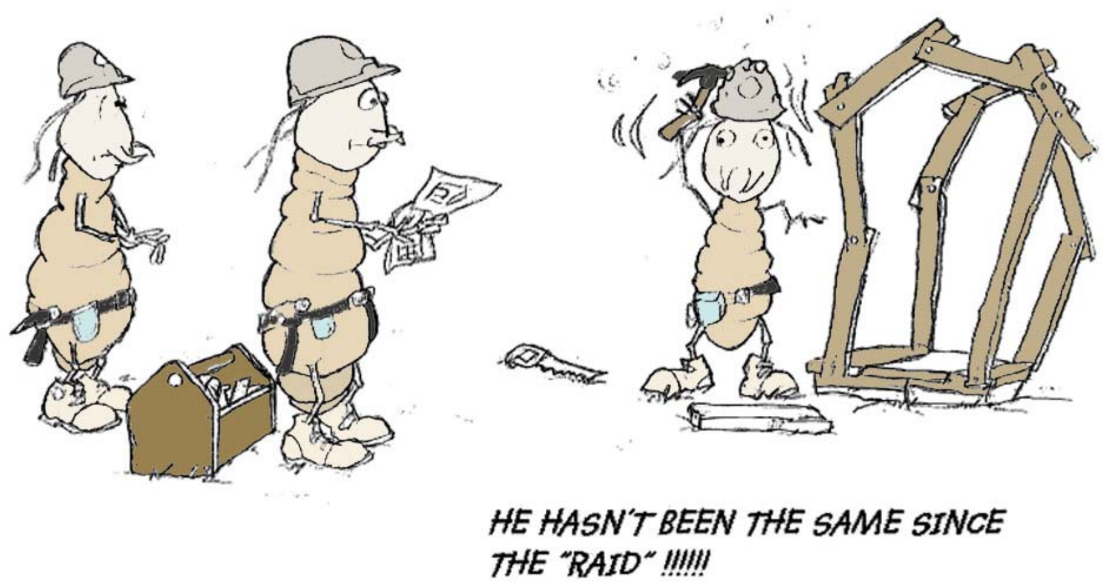
Risks associated with tank mixing may include a reduction in biological activity due to product antagonism. This may be present as crop scorch, which although it may be only transient, can often reduce final yield.

The most common limitation, however, is physical incompatibility, which can result in nozzle and filter blockage as well as phase separation in the spray tank where agitation is inadequate. This is common when during flights to the spray area (ferry flights) the spray pump is secured or turned off in the case of an electrically driven pump. This means that there is no circulation of the spray liquid back to the tank.

Where aircraft are refilled from a ground (“nurse”) tank, frequent re-circulation of the contents will ensure that there is no phase separation within the nurse tank. Product labels should give advice on tank mixing and approved mixture partners, information on the sequence of introducing the products into the tank and the need for agitation. Water temperature, quality and pH can also influence chemical stability of tank mixes.

Safety Section
The overall safety of crop protection chemicals must be the objective of all users and those engaged in the storage, distribution and retailing of agrochemicals.

Applicator, Worker or Handler Health Surveillance
The health of applicator, worker or handler's exposed to pesticide must be monitored. The surveillance should cover health records and medical checks, which can alert medical authorities of any health changes, which might be related to exposure during work with pesticides. Health surveillance should also help determine whether safety practices and the selection and use of PPE are adequate for the products being used.



PPE
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.
(xii) 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.

Product Transport and Storage
Transporting pesticides by road is usually controlled within respective State or federal regulations for the movement of dangerous goods, where emergency procedures in the event of a road accident are already in place. All pesticide manufacturers issue "Transport Emergency Cards ("Labels or Placards"), to vehicle drivers transporting hazardous goods, which may include pesticides.

As well as the journey from the retailer to the end user, pesticide containers will also be moved in and out of store and to the airstrip on the farm. Containers must be checked for leaks and damage and must always remain fully and clearly labeled. This is particularly important for aircraft spraying where large drums are stored outside and are exposed to the vagaries of the weather.

PESTICIDES MUST ONLY BE TRANSPORTED AND STORED IN THEIR ORIGINAL TRANSPORT CONTAINERS AND PACKAGES

It is usual for large quantities of pesticide to be stored and handled at permanent airstrips. Such stores must be secure, as they may be remote and not always attended. Shade must be provided for chemical stocks, particularly when they are packed in 55 gallon drums. Ground support staff must be fully conversant with procedures in the event of accidental spillage or applicator, worker or handler contamination at airstrips, which must have fully maintained first-aid kits, an emergency shower unit and adequate quantities of absorbent materials to deal with spillage.

Pesticide Storage Areas
Pesticide storage areas must be accessible in the case of an emergency. Storing pesticides on the farm may be covered by local legislation. Correct and safe storage is essential to maintain a safe working environment, to maximize product shelf life and to minimize the risk of fire and spillage.

Pesticides must be kept in a dedicated store, which is accessible in case of emergency and can be locked when not in use. When considering erecting a pesticide store, guidelines relating to construction materials, design, location, emergency procedures etc. can usually be obtained from national regulatory authorities. Under no circumstances must pesticides be stored near foodstuffs.

Product Handling
The product label is usually the first reference for guidance on handling formulated pesticide products. It will usually describe the requirements for the use of Personal Protective Equipment (PPE) both for handling the undiluted (concentrate) product and for diluted spray solution.

Applicator, worker or handler exposure and environmental contamination can be substantially reduced when closed filling systems are used to extract the product from its shipping container and deliver it either directly to the spray tank or via a metering system to a separate mixing tank. This avoids contact with the loading crew and accidental spillage. Some closed transfer systems can empty and rinse chemical containers automatically and can eliminate the need for rinsing empty containers and the disposal of the contaminated water.

Chemical Container Management
On no account must empty chemical containers be reused. Empty containers must be thoroughly washed and rendered unusable before disposal. Empty containers can be effectively cleaned by manual methods or by a closed transfer system that collects the washing water (rinsate). Empty containers must be collected and securely stored prior to disposal and should not be left unsecured at the mixing site.

Some states allow controlled burial for empty and thoroughly cleaned containers whilst high-temperature incineration is permitted in other cases. Local environmental pollution control regulations must be consulted.

Chemical container management can be facilitated where products are purchased in returnable containers. In this case sealed containers are returned to the manufacturer for re-filling; a process, which often can be repeated several times during the life of a container. An approved, compatible extraction system to both measure and extract the chemical for use is required and systems must be capable of handling products of different viscosities and containers of different closure sizes.

Accident Procedures

If spillage occurs during transport or handling a pesticide, this may result in a fire, injury to humans, property damage or environmental contamination. Rapid action must follow the accident to contain and minimize any adverse effects. Pesticide transporters and users must be familiar with label recommendations and procedures to be followed. In the event of an accident, the appropriate authorities (Environment, Water, Police etc) must be notified. Records must be kept of all incidents and remedial action taken. Only vehicles correctly equipped to carry pesticides must be used to transport product to the airstrip.

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.

Agricultural plant means any plant grown or maintained for commercial, research, or other purposes. Included in this definition are food, feed and fiber plants, trees, turf grass, flowers, shrubs, ornamentals, and seedlings (40 CFR).

Farm means any operation, other than a nursery or forest, engaged in the outdoor production of agricultural plants (40 CFR, Section 170.3).

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