WOOD DESTROYERS

PROFESSIONAL DEVELOPMENT
CONTINUING EDUCATION COURSE

Technical Learning College

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http://www.abctlc.com/downloads/PDF/WoodDestroyersASS.pdf

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

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

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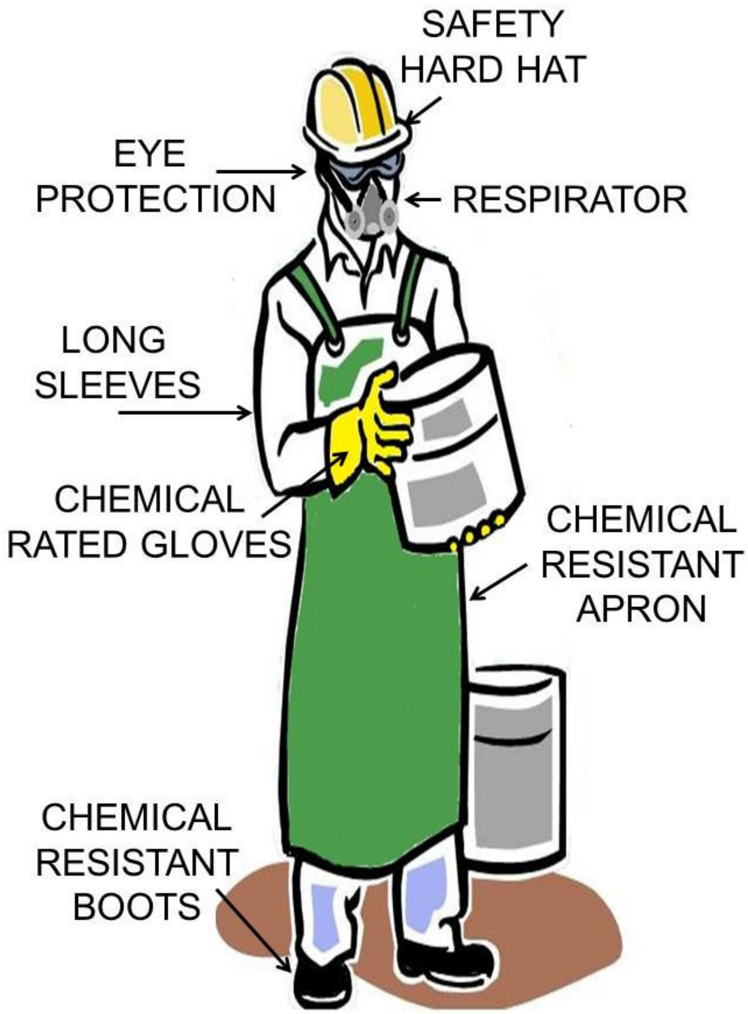

Pesticide Required PPE Diagram

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.

In late 2015 the Environmental Protection Agency issued the long awaited revision to the Worker Protection Standard (WPS). This law it is now technically active and it will be enforced. Please keep in mind that the WPS covers both restricted use AND general use pesticides. This course is not for worker and/or handler training. Always follow the label and your State Pesticide Agency rules.

Copyright Notice

TLC
P.O. Box 3060
Chino Valley, AZ 86323

Technical Learning College's Scope and Function

Welcome to the Program,

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

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

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

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

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

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

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

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

We welcome you to complete the assignment in Word. You can easily find the assignment at www.abctlc.com. Once complete, just simply fax or e-mail the answer key along with the registration page to us and allow two weeks for grading. Once we grade it, we will mail a certificate of completion to you.

Call us if you need any help.

Precept-Based Training CEU Course
This training course is made of "micro-content" or "precepts"– small chunks of information that can be easily digested. Using bite-size pieces of technical information is considered to be one of the most effective ways of teaching people new information because it helps the student to 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, and then demonstrate their knowledge in the final assessment.

CEU Course Description

Wood Destroyers CEU Training Course

This course is intended to serve as a source of detailed information needed to implement an integrated pest management program for identifying and control wood destroyers, insects, fungi and rot and to provide continuing education for pesticide applicators. This course will cover the majority of wood destroyers in the US and related pesticide treatments, rules and regulations and safety procedures. This course will primarily focus upon termites, ants and wood borers.

This CE course contains pesticide recommendations that are subject to change at any time. These training recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

This course reviews basic pesticide safety training information and wood destroyer application methods. This course is general in nature and not state specific. There are no prerequisites, and no other materials are needed for this course.

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, the student 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). 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.

Instructions for Written Assignments

The Wood Destroyers distance learning 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, or faxed to (928) 468-0675.

Grading Criteria
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.

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

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

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.

Important Information about this Manual

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

This manual will cover 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 course manual will provide 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 or a source or remedy for poison control.

Technical Learning College or Technical Learning Consultants, Inc. makes 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 should be used for educational purposes only and is not considered a legal document.

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

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

Please wear a respirator anytime you are working with product. Too many applicators have developed lung diseases and cancer from working with pesticides. I would say that many professional applicators will develop some pesticide related disease (cancer) and most of these diseases are because the applicator did not wear proper PPE or read and understand the dangers of the product.

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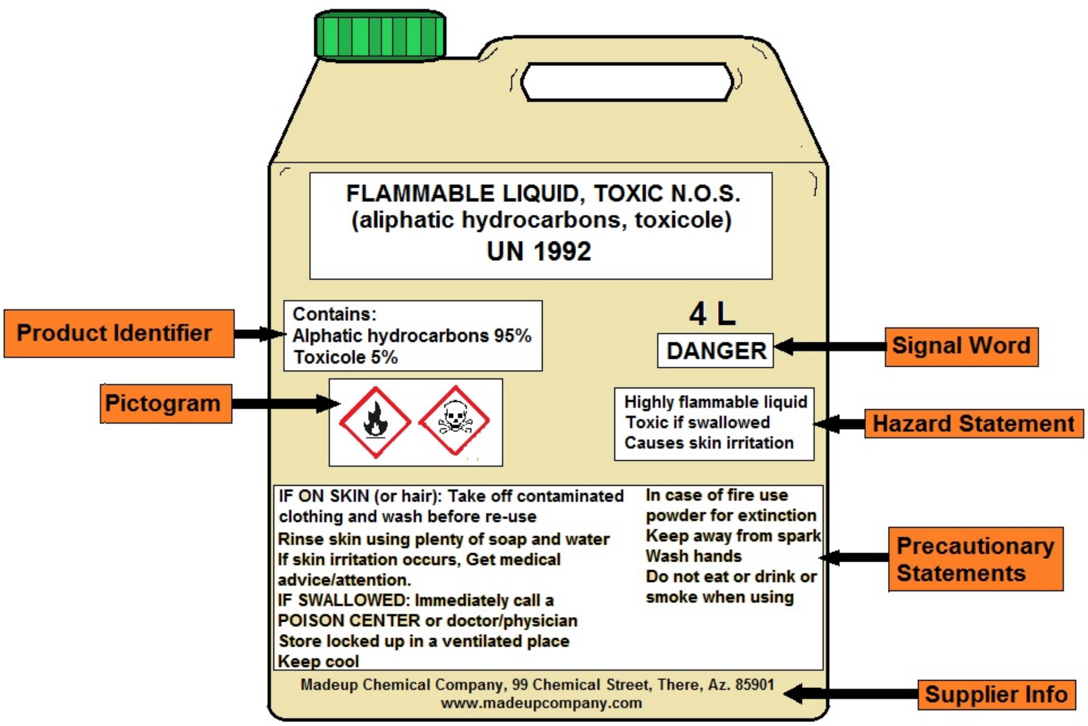


Technical Learning College

PESTICIDE LABEL DIAGRAM

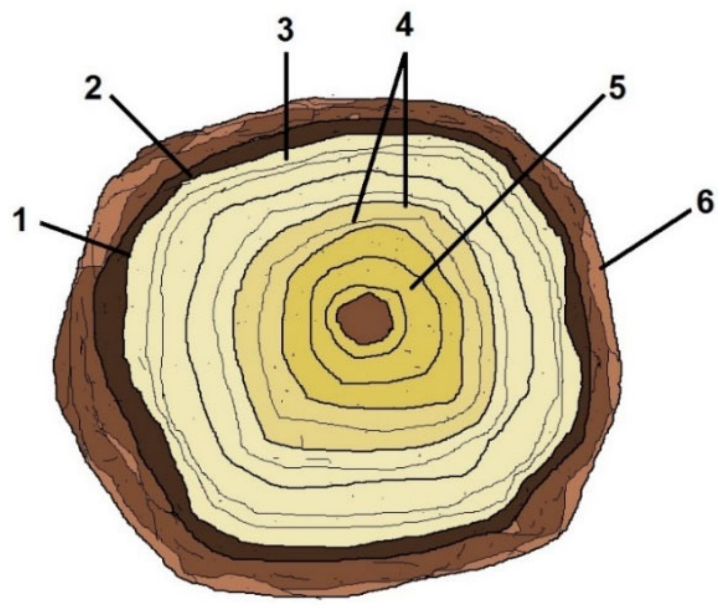
Topic 1 -Wood Pests - Living and Processed Wood

Topic 1 - Section Focus: You will learn the basics of wood, both processed, raw and living and an introduction to common tree/wood pests. At the end of this section, you will be able to describe trees and processed wood, and introduction to wood destroying pests. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Topic 1 – Scope/Background: Wood-destroying insects are a group of **pests** that pose one of the greatest threats to the structural integrity of trees, homes or commercial buildings. While some pests attack trees/wood to create nesting sites, others simply want to eat the wood (living/processed). Because wood cellulous is used in breads and many processed foods and alcohol, processors / distributors will hire pesticide applicators to control various fungus and molds in wood.

What is Wood?

Wood is a porous and fibrous structural tissue found in the stems and roots of trees and other woody plants. It is an organic material – a natural composite of cellulose fibers that are strong in tension and embedded in a matrix of lignin that resists compression. Wood is sometimes defined as only the secondary xylem in the stems of trees, or it is defined more broadly to include the same type of tissue elsewhere such as in the roots of trees or shrubs. In a living tree it performs a support function, enabling woody plants to grow large or to stand up by themselves. It also conveys water and nutrients between the leaves, other growing tissues, and the roots. Wood may also refer to other plant materials with comparable properties, and to material engineered from wood, or wood chips or fiber



CROSS SECTION OF A TREE

Trees/Wood Terms

Annual Growth
The yearly increase in wood volume, usually expressed in terms of board feet.

Annual Rings – See diagram on previous page
Bands that show tree growth for one year, as viewed on the cross section of a stem, branch or root, or on a trunk core sample. Can be counted to determine a tree's age. Variation in width of rings records how the tree responded to growing conditions in different years.

1 is called the **cambium**. It is a layer or zone of cells, just one cell thick, inside the inner bark. The cambium produces both the **xylem** and **phloem** cells. This is where diameter growth occurs, and where rings and inner bark are formed.

2 is the **phloem** or inner bark. This layer carries sugar made in the leaves or needles down to the branches trunks and roots, where it is converted into the food the tree needs for growth.

3 is the **xylem** or sapwood. This layer carries the sap (water plus nitrogen and mineral nutrients) back up from the roots to the leaves. Sapwood gives a tree its strength.

4 is a **growth ring**. The lighter portion is called the "early wood" (because it grows in the spring), and the darker portion the "late wood" (which grows in the summer). Together, they represent one year of growth. (You can count the rings to see how old a tree is!)

5 is the **heartwood**. Heartwood develops as a tree gets older. It is old sapwood that no longer carries sap, and gives the trunk support and stiffness. In many kinds of trees, heartwood is a darker color than sapwood, since its water-carrying tubes get clogged up. The tree cookie at right, like many of its fellow young pines, has not developed heartwood yet.

6 is the **outer bark**. This layer protects a tree from insects and disease, excessive heat and cold, and other injuries.

Best Management Practices
(Also known as "BMPs")
Common-sense actions required, by law, to keep soil and other pollutants out of streams and lakes. BMPs are designed to protect water quality and to prevent new pollution.

Board Foot
A unit for measuring wood volumes equaling 144 cubic inches, commonly used to measure and express the amount of wood in a tree, sawlog or individual piece of lumber. For example, a piece of wood measuring 1-foot x 1-foot x 1-inch or a piece measuring 1-foot x 2-inches x 6-inches each contain 1 board foot of wood.

Buffer Strip
A protective strip of land or timber adjacent to an area requiring attention or protection. For example, a protective strip of un-harvested timber along a stream.

Burning Methods
Controlled Burn: Any burning that a landowner starts intentionally and controls to accomplish a particular purpose, such as brush or slash reduction. *Prescribed Burn:* Application of fire to land under conditions of weather, soil moisture and timer of day that will accomplish specific silvicultural, wildlife, grazing or fire-hazard-reduction purposes.

Canopy
The tree crowns in a stand.

Commercial Timberland
Forestland that is producing or capable of producing at least 20 cubic feet of industrial wood per acre per year and is not withdrawn from timber utilization by statute or administrative regulation.

Cord
A stack of wood containing 128 cubic feet. The standard dimensions are 4 x 4 x 8 feet.

Crown
The branches and foliage of a tree.

Cruise
A survey of forest land to estimate timber quantity.

Forest
A plant community dominated by trees and other woody plants.

Forester
An educated professional responsible for planning and producing healthy and sustainable forests.

Forest Industries
A diverse group of manufacturers that harvest, process and use timber products in their final products. Activities include the harvesting of the timber resource; conversion of logs to primary timber products such as lumber, plywood and wood pulp; and the conversion of primary timber products to secondary or final products such as pallets, furniture and paper products.

Forest Lands
Land at least 10 percent stocked by tree stands of any size or that formerly had such tree cover and that will be regenerated with trees.

Forest Practices
All activities involved with the growth, harvesting and reforestation of forest tree species.

Forest Type
A group of tree species that, because of their environmental requirements, commonly grow together. Examples of forest types are the Douglas-fir/hemlock type or the spruce/fir type. Also, a descriptive term used to group stands with similar composition and development characteristics.

Fuelwood
Wood used for conversion to some form of energy, primarily for residential use.

Growing Stock
A classification of timber inventory that includes live trees of commercial species meeting specified standards of quality and vigor. When associated with volume, includes only trees 5.0 inches in diameter breast-height (DBH) and larger.

Harvesting
Removing mature trees to improve the growing conditions for other trees in the forest and to provide raw materials for human use.

Log Rule
A table that expresses log volume based on log diameter and length. The Scribner Decimal C Rule is the legal rule in many states.

Log Scale
The lumber content of a log as determined by a log rule.

Natural Regeneration
The process of forest growth, with young plants sprouting from seeds that have been naturally dropped upon the soil.

Non-industrial Private Forest
Forestland owned by farmers, ranchers and all other individuals and corporations that do not operate wood-processing plants.

Non-Structural Panels
Hardwood panels, hardboard, insulating board, particleboard and medium-density fiberboard used in construction.

Pulpwood
Roundwood, whole-tree chips or wood residues that are used for the production of wood pulp.

Reforestation
The act of replanting or reseeding a forest area to replace trees removed by harvest or destroyed by fire, wind or disease.

Roundwood
Logs, bolts or other round sections cut from growing stock and non-growing stock sources: includes sawlogs, pulpwood, pilings and poles.

Salvage Cutting
The removal of dead trees or trees being damaged or killed by injurious agents other than competition, to recover value that would otherwise be lost.

Sawlog
A log usually used in the manufacture of lumber of veneer, meeting minimum standards of diameter, length and defect.

Seedling
A small tree which has been produced from a seed.

Silviculture
The art, science and practice of controlling the establishment, growth, composition, health and quality of forests and woodlands. Silviculture entails the manipulation of forest and woodland vegetation in stands and on landscapes to meet the diverse needs and values of landowners and society on a sustainable basis.

Stand
A contiguous group of trees sufficiently uniform in age class distribution, composition and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit.

Structural Panels
Softwood plywood, waferboard, oriented board, particleboard and composite board used in construction.

Sustained Yield
Harvest practices which, over time, ensure that the rate of timber harvest does not exceed the rate of timber growth.

Thinning
A cutting made to reduce stand density of trees primarily to improve growth, enhance forest health or to recover potential mortality.

Timber Growth
Represents a purely biological measure of timber output. It is the amount of timber produced in the forest and stored "on the stump" for both present and future consumption.

Timber Mortality
The volume of sound trees that die annually from natural causes such as insects, disease, competition from other trees, fire and windthrow.

Windthrow
The uprooting and overthrowing of trees by the wind.

Understanding Wood Sub-Section

Wood, in the strict sense, is yielded by trees, which increase in diameter by the formation, between the existing wood and the inner bark, of new woody layers which envelop the entire stem, living branches, and roots. Technically this is known as secondary growth; it is the result of cell division in the vascular cambium, a lateral meristem, and subsequent expansion of the new cells.

The lighter portion is called the "early wood" (because it grows in the spring), and the darker portion the "late wood" (which grows in the summer). Together, they represent one year of growth. Heartwood develops as a tree gets older. It is old sapwood that no longer carries sap, and gives the trunk support and stiffness. In many kinds of trees, heartwood is a darker color than sapwood, since its water-carrying tubes get clogged up.

Growth Rings
Where there are clear seasons, growth can occur in a discrete annual or seasonal pattern, leading to growth rings; these can usually be most clearly seen on the end of a log, but are also visible on the other surfaces. If these seasons are annual these growth rings are referred to as annual rings. Where there is no seasonal difference growth rings are likely to be indistinct or absent.

If there are differences within a growth ring, then the part of a growth ring nearest the center of the tree and formed early in the growing season when growth is rapid, is usually composed of wider elements. It is usually lighter in color than that near the outer portion of the ring, and is known as earlywood or springwood.

The outer portion formed later in the season is then known as the latewood or summerwood. However, there are major differences, depending on the kind of wood (see below).

Knots

A knot is a particular type of imperfection in a piece of wood; it will affect the technical properties of the wood, usually for the worse, but may be exploited for artistic effect. In a longitudinally sawn plank, a knot will appear as a roughly circular "solid" (usually darker) piece of wood around which the grain of the rest of the wood "flows" (parts and rejoins). Within a knot, the direction of the wood (grain direction) is up to 90 degrees different from the grain direction of the regular wood.

In the tree a knot is either the base of a side branch or a dormant bud. A knot (when the base of a side branch) is conical in shape (hence the roughly circular cross-section) with the tip at the point in stem diameter at which the plant's cambium [disambiguation needed] was located when the branch formed as a bud.

During the development of a tree, the lower limbs often die, but may persist for a time, sometimes years. Subsequent layers of growth of the attaching stem are no longer intimately joined with the dead limb, but are grown around it. Hence, dead branches produce knots which are not attached, and likely to drop out after the tree has been sawn into boards.

Grading Lumber

In grading lumber and structural timber, knots are classified according to their form, size, soundness, and the firmness with which they are held in place. This firmness is affected by, among other factors, the length of time for which the branch was dead while the attaching stem continued to grow.

Knots materially affect cracking (known as checking) and warping, ease in working, and cleavability of timber. They are defects which weaken timber and lower its value for structural purposes where strength is an important consideration. The weakening effect is much more serious when timber is subjected to forces perpendicular to the grain and/or tension than where under load along the grain and/or compression. The extent to which knots affect the strength of a beam depends upon their position, size, number, and condition.

A knot on the upper side is compressed, while one on the lower side is subjected to tension. If there is a season check in the knot, as is often the case, it will offer little resistance to this tensile stress.

Small knots, however, may be located along the neutral plane of a beam and increase the strength by preventing longitudinal shearing. Knots in a board or plank are least injurious when they extend through it at right angles to its broadest surface. Knots which occur near the ends of a beam do not weaken it.

Sound knots which occur in the central portion one-fourth the height of the beam from either edge are not serious defects.

Knots do not necessarily influence the stiffness of structural timber, this will depend on the size and location. Stiffness and elastic strength are more dependent upon the sound wood than upon localized defects. The breaking strength is very susceptible to defects. Sound knots do not weaken wood when subject to compression parallel to the grain.

In some decorative applications, wood with knots may be desirable to add visual interest. In applications where wood is painted, such as skirting boards, fascia boards, door frames and furniture, resins present in the timber may continue to 'bleed' through to the surface of a knot for months or even years after manufacture and show as a yellow or brownish stain. A Knot Primer paint or solution, correctly applied during preparation, may do much to reduce this problem but it is difficult to control completely, especially when using mass-produced kiln-dried timber stocks.

Heartwood and Sapwood
Heartwood is wood that as a result of a naturally occurring chemical transformation has become more resistant to decay. Heartwood formation occurs spontaneously (it is a genetically programmed process). Once heartwood formation is complete, the heartwood is dead. Some uncertainty still exists as to whether heartwood is truly dead, as it can still chemically react to decay organisms, but only once (Shigo 1986, 54).

Usually heartwood looks different; in that case it can be seen on a cross-section, usually following the growth rings in shape. Heartwood may (or may not) be much darker than living wood. It may (or may not) be sharply distinct from the sapwood. However, other processes, such as decay, can discolor wood, even in woody plants that do not form heartwood, with a similar color difference, which may lead to confusion.

Sapwood is the younger, outermost wood; in the growing tree it is living wood, and its principal functions are to conduct water from the roots to the leaves and to store up and give back according to the season the reserves prepared in the leaves. However, by the time they become competent to conduct water, all xylem tracheids and vessels have lost their cytoplasm and the cells are therefore functionally dead.

Sapwood
All wood in a tree is first formed as sapwood. The more leaves a tree bears and the more vigorous its growth, the larger the volume of sapwood required. Hence trees making rapid growth in the open have thicker sapwood for their size than trees of the same species growing in dense forests. Sometimes trees (of species that do form heartwood) grown in the open may become of considerable size, 12 inches (30 cm) or more in diameter, before any heartwood begins to form, for example, in second-growth hickory, or open-grown pines.

The term heartwood derives solely from its position and not from any vital importance to the tree. This is evidenced by the fact that a tree can thrive with its heart completely decayed. Some species begin to form heartwood very early in life, so having only a thin layer of live sapwood, while in others the change comes slowly.

Thin sapwood is characteristic of such species as chestnut, black locust, mulberry, osage-orange, and sassafras, while in maple, ash, hickory, hackberry, beech, and pine, thick sapwood is the rule. Others never form heartwood.

There is no definite relation between the annual rings of growth and the amount of sapwood. Within the same species the cross-sectional area of the sapwood is very roughly proportional to the size of the crown of the tree. If the rings are narrow, more of them are required than where they are wide.

As the tree gets larger, the sapwood must necessarily become thinner or increase materially in volume. Sapwood is thicker in the upper portion of the trunk of a tree than near the base, because the age and the diameter of the upper sections are less.

When a tree is very young it is covered with limbs almost, if not entirely, to the ground, but as it grows older some or all of them will eventually die and are either broken off or fall off. Subsequent growth of wood may completely conceal the stubs which will however remain as knots. No matter how smooth and clear a log is on the outside, it is more or less knotty near the middle. Consequently the sapwood of an old tree, and particularly of a forest-grown tree, will be freer from knots than the inner heartwood. Since in most uses of wood, knots are defects that weaken the timber and interfere with its ease of working and other properties, it follows that a given piece of sapwood, because of its position in the tree, may well be stronger than a piece of heartwood from the same tree.

It is remarkable that the inner heartwood of old trees remains as sound as it usually does, since in many cases it is hundreds, and in a few instances thousands, of years old. Every broken limb or root, or deep wound from fire, insects, or falling timber, may afford an entrance for decay, which, once started, may penetrate to all parts of the trunk. The larvae of many insects bore into the trees and their tunnels remain indefinitely as sources of weakness. Whatever advantages, however, that sapwood may have in this connection are due solely to its relative age and position.

Annual Rings

If a tree grows all its life in the open and the conditions of soil and site remain unchanged, it will make its most rapid growth in youth, and gradually decline. The annual rings of growth are for many years quite wide, but later they become narrower and narrower. Since each succeeding ring is laid down on the outside of the wood previously formed, it follows that unless a tree materially increases its production of wood from year to year, the rings must necessarily become thinner as the trunk gets wider.

As a tree reaches maturity its crown becomes more open and the annual wood production is lessened, thereby reducing still more the width of the growth rings. In the case of forest-grown trees so much depends upon the competition of the trees in their struggle for light and nourishment that periods of rapid and slow growth may alternate. Some trees, such as southern oaks, maintain the same width of ring for hundreds of years. Upon the whole, however, as a tree gets larger in diameter the width of the growth rings decreases.

Tree Pests Damage Photos

Evidence of Longhorned beetles in above photo.

Evidence of Carpenter bee in above photo. Note: Woodpeckers do not drill holes longer than their beaks. Woodpecker are great wood destroyers, even on the sides of houses but the damage is only about 1 inch deep. You will probably go to prison if you try to control a woodpecker without a permit. Endangered species act and wildlife regulations are very strict.

Evidence of Powder Post beetles in above photo.

The term "carpenter ant" is applied broadly to several species of ants that nest in or around wood. Our concern is with ants in the genus, *Camponotus*. Some of these species actually tunnel into the wood, while other species prefer to nest in existing cavities. There make an oval shape cut in the wood.

Hard and Soft Woods

There is a strong relationship between the properties of wood and the properties of the particular tree that yielded it. For every tree species there is a range of density for the wood it yields. There is a rough correlation between density of a wood and its strength (mechanical properties). For example, while mahogany is a medium-dense hardwood which is excellent for fine furniture crafting, balsa is light, making it useful for model building. The densest wood may be black ironwood. It is common to classify wood as either softwood or hardwood. The wood from conifers (e.g. pine) is called softwood, and the wood from dicotyledons (usually broad-leaved trees, e.g. oak) is called hardwood. These names are a bit misleading, as hardwoods are not necessarily hard, and softwoods are not necessarily soft. The well-known balsa (a hardwood) is actually softer than any commercial softwood. Conversely, some softwoods (e.g. yew) are harder than many hardwoods. Engineered wood products have properties that usually differ from those of natural timbers.

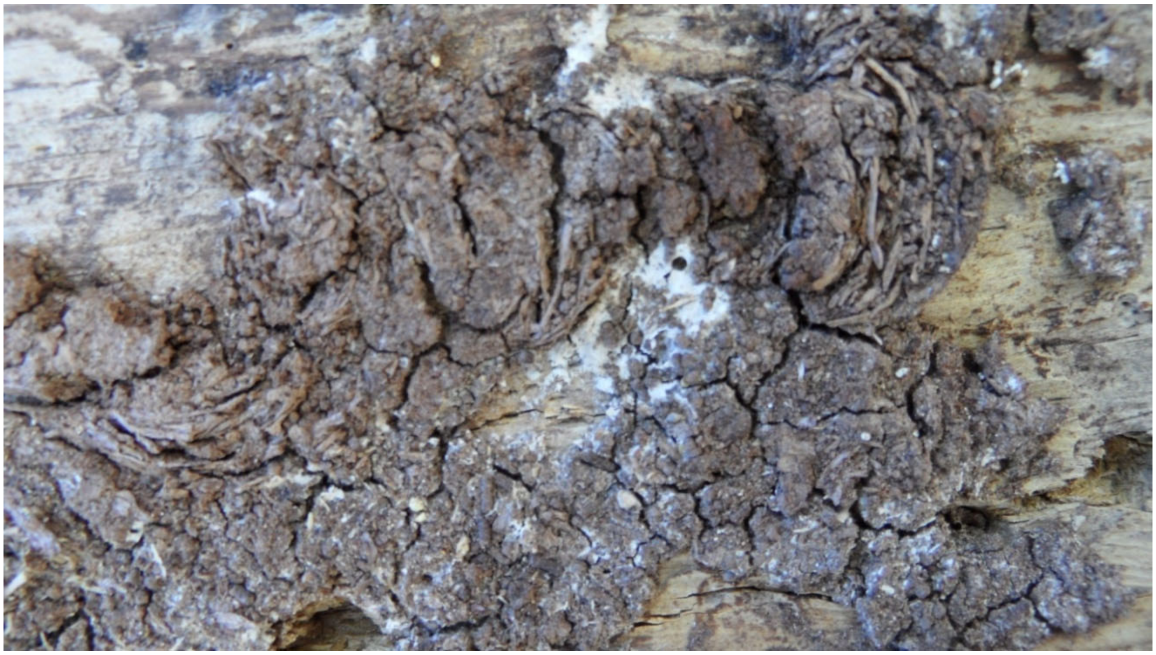
Color
In species which show a distinct difference between heartwood and sapwood the natural color of heartwood is usually darker than that of the sapwood, and very frequently the contrast is conspicuous (see section of yew log above). This is produced by deposits in the heartwood of chemical substances, so that a dramatic color difference does not mean a dramatic difference in the mechanical properties of heartwood and sapwood, although there may be a dramatic chemical difference.

Some experiments on very resinous Longleaf Pine specimens indicate an increase in strength, due to the resin which increases the strength when dry. Such resin-saturated heartwood is called "fat lighter". Structures built of fat lighter are almost impervious to rot and termites; however they are very flammable.

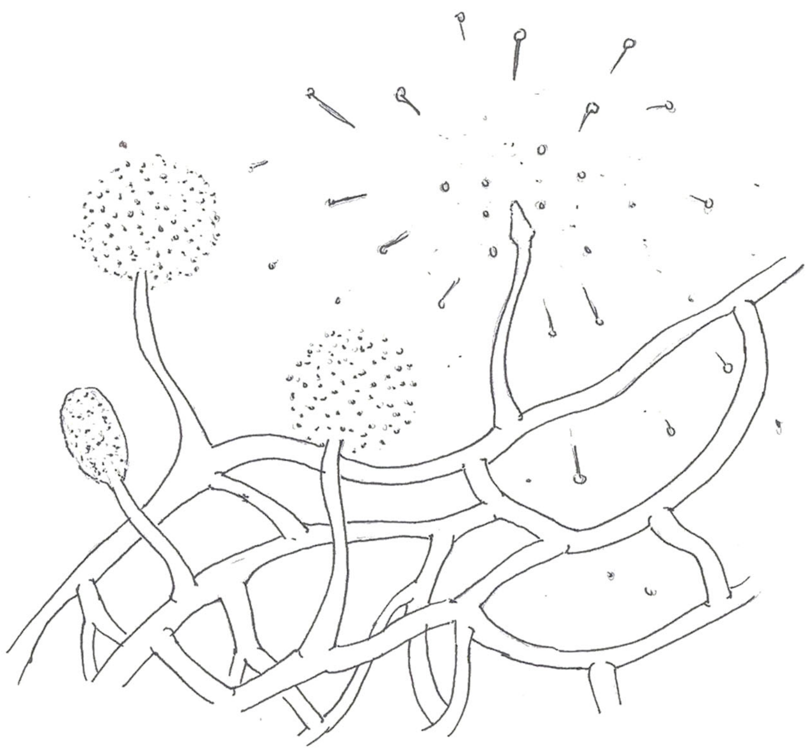
Stumps of old longleaf pines are often dug, split into small pieces and sold as kindling for fires. Stumps thus dug may actually remain a century or more since being cut. Spruce impregnated with crude resin and dried is also greatly increased in strength thereby.

Since the latewood of a growth ring is usually darker in color than the earlywood, this fact may be used in judging the density, and therefore the hardness and strength of the material. This is particularly the case with coniferous woods. In ring-porous woods the vessels of the early wood not infrequently appear on a finished surface as darker than the denser latewood, though on cross sections of heartwood the reverse is commonly true. Except in the manner just stated the color of wood is no indication of strength.

Abnormal discoloration of wood often denotes a diseased condition, indicating unsoundness. The black check in western hemlock is the result of insect attacks. The reddish-brown streaks so common in hickory and certain other woods are mostly the result of injury by birds. The discoloration is merely an indication of an injury, and in all probability does not of itself affect the properties of the wood.



WHITE FUNGUS EXAMPLE



SPORES SPREAD DECAY FUNGUS

Rot-Producing Fungi- More in Topic #6

Certain rot-producing fungi impart to wood characteristic colors which thus become symptomatic of weakness; however an attractive effect known as spalting produced by this process is often considered a desirable characteristic. Ordinary sap-staining is due to fungous growth, but does not necessarily produce a weakening effect.

Structure
Wood is a heterogeneous, hygroscopic, cellular and anisotropic material. It is composed of cells, and the cell walls are composed of micro-fibrils of cellulose (40% – 50%) and hemicellulose (15% – 25%) impregnated with lignin (15% – 30%). In coniferous or softwood species the wood cells are mostly of one kind, tracheids, and as a result the material is much more uniform in structure than that of most hardwoods. There are no vessels ("pores") in coniferous wood such as one sees so prominently in oak and ash, for example.

The structure of hardwoods is more complex. The water conducting capability is mostly taken care of by vessels: in some cases (oak, chestnut, ash) these are quite large and distinct, in others (buckeye, poplar, willow) too small to be seen without a hand lens. In discussing such woods it is customary to divide them into two large classes, ring-porous and diffuse-porous. In ring-porous species, such as ash, black locust, catalpa, chestnut, elm, hickory, mulberry, and oak, the larger vessels or pores (as cross sections of vessels are called) are localized in the part of the growth ring formed in spring, thus forming a region of more or less open and porous tissue.

The rest of the ring, produced in summer, is made up of smaller vessels and a much greater proportion of wood fibers. These fiber are the elements which give strength and toughness to wood, while the vessels are a source of weakness. In diffuse-porous woods the pores are evenly sized so that the water conducting capability is scattered throughout the growth ring instead of being collected in a band or row. Examples of this kind of wood are basswood, birch, buckeye, maple, poplar, and willow. Some species, such as walnut and cherry, are on the border between the two classes, forming an intermediate group.

Earlywood and Latewood in Softwood
In temperate softwoods there often is a marked difference between latewood and earlywood. The latewood will be denser than that formed early in the season. When examined under a microscope the cells of dense latewood are seen to be very thick-walled and with very small cell cavities, while those formed first in the season have thin walls and large cell cavities. The strength is in the walls, not the cavities. Hence the greater the proportion of latewood the greater the density and strength. In choosing a piece of pine where strength or stiffness is the important consideration, the principal thing to observe is the comparative amounts of earlywood and latewood. The width of ring is not nearly so important as the proportion and nature of the latewood in the ring.

If a heavy piece of pine is compared with a lightweight piece it will be seen at once that the heavier one contains a larger proportion of latewood than the other, and is therefore showing more clearly demarcated growth rings. In white pines there is not much contrast between the different parts of the ring, and as a result the wood is very uniform in texture and is easy to work. In hard pines, on the other hand, the latewood is very dense and is deep-colored, presenting a very decided contrast to the soft, straw-colored earlywood. It is not only the proportion of latewood, but also its quality, that counts. In specimens that show a very large proportion of latewood it may be noticeably more porous and weigh considerably less than the latewood in pieces that contain but little. One can judge comparative density, and therefore to some extent strength, by visual inspection.

No satisfactory explanation can as yet be given for the exact mechanisms determining the formation of earlywood and latewood. Several factors may be involved. In conifers, at least, rate of growth alone does not determine the proportion of the two portions of the ring, for in some cases the wood of slow growth is very hard and heavy, while in others the opposite is true. The quality of the site where the tree grows undoubtedly affects the character of the wood formed, though it is not possible to formulate a rule governing it. In general, however, it may be said that where strength or ease of working is essential, woods of moderate to slow growth should be chosen.

Earlywood and Latewood in Ring-Porous Woods

In ring-porous woods each season's growth is always well defined, because the large pores formed early in the season abut on the denser tissue of the year before. In the case of the ring-porous hardwoods there seems to exist a pretty definite relation between the rate of growth of timber and its properties. This may be briefly summed up in the general statement that the more rapid the growth or the wider the rings of growth, the heavier, harder, stronger, and stiffer the wood. This, it must be remembered, applies only to ring-porous woods such as oak, ash, hickory, and others of the same group, and is, of course, subject to some exceptions and limitations.

In ring-porous woods of good growth it is usually the latewood in which the thick-walled, strength-giving fibers are most abundant. As the breadth of ring diminishes, this latewood is reduced so that very slow growth produces comparatively light, porous wood composed of thin-walled vessels and wood parenchyma. In good oak these large vessels of the earlywood occupy from 6 to 10 per cent of the volume of the log, while in inferior material they may make up 25 per cent or more.

The latewood of good oak is dark colored and firm, and consists mostly of thick-walled fibers which form one-half or more of the wood. In inferior oak, this latewood is much reduced both in quantity and quality. Such variation is very largely the result of rate of growth.

Second Growth

Wide-ringed wood is often called "second-growth", because the growth of the young timber in open stands after the old trees have been removed is more rapid than in trees in a closed forest, and in the manufacture of articles where strength is an important consideration such "second-growth" hardwood material is preferred. This is particularly the case in the choice of hickory for handles and spokes. Here not only strength, but toughness and resilience are important. The results of a series of tests on hickory by the U.S. Forest Service show that:

"The work or shock-resisting ability is greatest in wide-ringed wood that has from 5 to 14 rings per inch (rings 1.8-5 mm thick), is fairly constant from 14 to 38 rings per inch (rings 0.7-1.8 mm thick), and decreases rapidly from 38 to 47 rings per inch (rings 0.5-0.7 mm thick).

The strength at maximum load is not so great with the most rapid-growing wood; it is maximum with from 14 to 20 rings per inch (rings 1.3-1.8 mm thick), and again becomes less as the wood becomes more closely ringed.

The natural deduction is that wood of first-class mechanical value shows from 5 to 20 rings per inch (rings 1.3-5 mm thick) and that slower growth yields poorer stock. Thus the inspector or buyer of hickory should discriminate against timber that has more than 20 rings per inch (rings less than 1.3 mm thick). Exceptions exist, however, in the case of normal growth upon dry situations, in which the slow-growing material may be strong and tough."

The effect of rate of growth on the qualities of chestnut wood is summarized by the same authority as follows:
"When the rings are wide, the transition from spring wood to summer wood is gradual, while in the narrow rings the spring wood passes into summer wood abruptly. The width of the spring wood changes but little with the width of the annual ring, so that the narrowing or broadening of the annual ring is always at the expense of the summer wood.

The narrow vessels of the summer wood make it richer in wood substance than the spring wood composed of wide vessels. Therefore, rapid-growing specimens with wide rings have more wood substance than slow-growing trees with narrow rings.

Since the more the wood substance the greater the weight, and the greater the weight the stronger the wood, chestnuts with wide rings must have stronger wood than chestnuts with narrow rings. This agrees with the accepted view that sprouts (which always have wide rings) yield better and stronger wood than seedling chestnuts, which grow more slowly in diameter."

Earlywood and Latewood in Diffuse-Porous Woods
In the diffuse-porous woods, the demarcation between rings is not always so clear and in some cases is almost (if not entirely) invisible to the unaided eye. Conversely, when there is a clear demarcation there may not be a noticeable difference in structure within the growth ring.

In diffuse-porous woods, as has been stated, the vessels or pores are even-sized, so that the water conducting capability is scattered throughout the ring instead of collected in the earlywood.

The effect of rate of growth is, therefore, not the same as in the ring-porous woods, approaching more nearly the conditions in the conifers.

In general, it may be stated that such woods of medium growth afford stronger material than when very rapidly or very slowly grown. In many uses of wood, total strength is not the main consideration. If ease of working is prized, wood should be chosen with regard to its uniformity of texture and straightness of grain, which will in most cases occur when there is little contrast between the latewood of one season's growth and the earlywood of the next.

Different pieces of wood cut from a large tree may differ decidedly, particularly if the tree is big and mature. In some trees, the wood laid on late in the life of a tree is softer, lighter, weaker, and more even-textured than that produced earlier, but in other trees, the reverse applies. This may or may not correspond to heartwood and sapwood. In a large log the sapwood, because of the time in the life of the tree when it was grown, may be inferior in hardness, strength, and toughness to equally sound heartwood from the same log. In a smaller tree, the reverse may be true.

Common wood mold removers/preservatives

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.

Monocot Wood (Palms)

Structural material that roughly (in its gross handling characteristics) resembles ordinary, "dicot" or conifer wood is produced by a number of monocot plants, and these also are colloquially called wood. Of these, bamboo, botanically a member of the grass family has considerable economic importance, larger culms being widely used as a building and construction material in their own right and, these days, in the manufacture of engineered flooring, panels and veneer. Another major plant group that produces material that often is called wood are the palms. Of much less importance are plants such as Pandanus, Dracaena and Cordyline. With all this material, the structure and composition of the structural material is quite different from ordinary wood.

Monocot Wood (Common Parrot Nesting Sites)

Water Content

Water occurs in living wood in three conditions, namely: (1) in the cell walls, (2) in the protoplasmic contents of the cells, and (3) as free water in the cell cavities and spaces. In heartwood it occurs only in the first and last forms. Wood that is thoroughly air-dried retains from 8-16% of water in the cell walls, and none, or practically none, in the other forms. Even oven-dried wood retains a small percentage of moisture, but for all except chemical purposes, may be considered absolutely dry. The general effect of the water content upon the wood substance is to render it softer and more pliable.

A similar effect of common observation is in the softening action of water on paper or cloth. Within certain limits, the greater the water content, the greater it's softening effect. Drying produces a decided increase in the strength of wood, particularly in small specimens. An extreme example is the case of a completely dry spruce block 5 cm in section, which will sustain a permanent load four times as great as that which a green (undried) block of the same size will support. The greatest increase due to drying is in the ultimate crushing strength and strength at elastic limit in endwise compression; these are followed by the modulus of rupture, and stress at elastic limit in cross-bending, while the modulus of elasticity is least affected.

Engineered Wood

Wood used in construction includes products such as glued laminated timber (glulam), laminated veneer lumber (LVL), parallam and I-joists. On the one hand these allow the use of smaller pieces, and on the other hand allow bigger spans. They may also be selected for specific projects such as public swimming pools or ice rinks where the wood will not deteriorate in the presence of certain chemicals.

These engineered wood products prove to be more environmentally friendly, and sometimes cheaper, than building materials such as steel or concrete. Wood unsuitable for construction in its native form may be broken down mechanically (into fibers or chips) or chemically (into cellulose) and used as a raw material for other building materials such as chipboard, engineered wood, hardboard, medium-density fiberboard (MDF), oriented strand board (OSB). Such wood derivatives are widely used: wood fibers are an important component of most paper, and cellulose is used as a component of some synthetic materials. Wood derivatives can also be used for kinds of flooring, for example laminate flooring.

Pressure treated wood

Wood Destroying Preservatives Introduction
More in Topic #5

Insects and mold can damage wood over time. To prevent that damage, wood is often treated with pesticides. Treated wood is commonly used to build telephone poles, road signs and marine pilings as well as decks, play structures and raised garden beds. Several wood preservatives are registered with the EPA, each with different uses and potential risks. Wood preservatives can extend the life of wood and reduce the need for forest resources, but proper use is important. Some preservatives can slowly leach into the surrounding soil or water. Sometimes, touching the wood can leave residue on exposed skin. Use the resources below to learn about selecting and using treated wood properly.

All measures that are taken to ensure a long life of wood fall under the definition wood preservation (timber treatment). Apart from structural wood preservation measures, there are a number of different (chemical) preservatives and processes (also known as timber treatment or lumber treatment) that can extend the life of wood, timber, wood structures or engineered wood. These generally increase the durability and resistance from being destroyed by insects or fungus.
Wood in contact with the ground, or wood used above ground that often gets wet, is attacked by decay fungi and insects. Two common examples of this type of application are decks and fence posts. With the exception of naturally durable species such as redwood and cedar, wood used in these applications should be pressure treated with preservatives if it is expected to last more than a few years.

For several decades, consumers have been able to purchase pressure-treated wood at their local lumber yards. This type of treated wood, commonly called "green treated," was most likely pressure impregnated with a preservative called chromated copper arsenate (CCA). CCA is an extremely effective and durable treatment against both decay and insect damage. This relatively inexpensive preservative treatment has been used since the 1940s. Alternative preservative treatments are now available.

CCA
Wood industrially pressure-treated with approved preservative products pose a limited risk to the public, but should be disposed of properly. On December 31, 2003, the US wood treatment industry stopped treating residential lumber with arsenic and chromium (chromated copper arsenate, or CCA). This was a voluntary agreement with the United States Environmental Protection Agency. CCA was replaced by copper based pesticides, with exceptions for certain industrial uses.

Industrial wood preservation chemicals are generally not available directly to the public and may require special approval to import or purchase depending on the product and the jurisdiction where being used. In most countries, industrial wood preservation operations are notifiable industrial activities that require licensing from relevant regulatory authorities such as EPA or equivalent. Reporting and licensing conditions vary widely depending on the particular chemicals used and the country of use.

Although pesticides are used to treat lumber, preserving lumber protects natural resources by enabling wood products to last longer. Previous poor practices in industry have left legacies of contaminated ground and water around wood treatment sites in some cases. In considering preservative treatment processes and wood species, the combination must provide the required protection for the conditions of exposure and life of the structure.

All these factors are considered by the consensus technical committees in setting reference levels required by the American Wood Protection Association (AWPA, formerly American Wood-Preservers' Association)) and ASTM International (formerly American Society for Testing and Materials).

Details are discussed later in this section. The characteristics, appropriate uses, and availability of preservative formulations may have changed after preparation of this course manual. For the most current information on preservative formulations, the reader is encouraged to contact the appropriate regulatory agencies, standardization organizations, or trade associations. Note that mention of a chemical in this section does not constitute a recommendation.

When using treated wood, keep these tips in mind:

- Make sure you select the proper type of treated wood for the job. Some treated wood and wood preservatives are restricted to specific uses.
- Consider wearing gloves when handling unsealed treated wood to reduce exposure to your skin.
- Consider wearing a dust mask while cutting treated wood to help prevent treated sawdust from being inhaled. Even untreated wood can irritate a person's airways.
- Never burn treated wood. Toxic chemicals can be released in the smoke.
- Consider using paint, varnish or some other type of sealant on treated wood as a barrier between the chemical and the surrounding environment.

Major Wood Destroyer Threats- Pest Introduction

Proper Identification of Wood Destroying Pests

POWDERPOST BEETLES

1. In processed wood, numerous small holes less than 3/ 8 inch in diameter. If the piece is split open, many frass-filled tunnels can be seen, most of them running with the grain. Family Bostrichidae (branch and twig borers, bostrichid beetles, horned powderpost beetles)

2. Exit holes 1/ 16 to 1/8 inch in diameter. More advanced galleries running across the grain. Frass consists in part of distinct elongate or bun-shaped pellets. In hard- and softwoods.
Family Bostrichidae (branch and twig borers, bostrichid beetles, horned powderpost beetles)

3. Exit holes vary from 1/ 8 to 3/8 inch in diameter. Occasional tunnels go across the grain but mostly with the grain. Fine or coarse frass that tends to stick together; few if any pellets. In hardwoods such as ash, oak, and hickory; sometimes in softwoods. Family Anobiidae (**drugstore** and deathwatch beetles) Live in dry vegetable materials; some species

destructive pests; examples Xestobium, Stegobium, Lasioderma; about 1,100 widely distributed species.

4. Exit holes 1/32 to 1/16 inch in diameter in newer or poorly seasoned hardwood lumber. (Common in poorly seasoned lumber.) Frass in tunnels is loose and powdery and contains no pellets. *Family Lyctidae* Powderpost beetles are a group of seventy species of woodboring beetles classified in the insect subfamily Lyctinae. These beetles, along with spider beetles, death watch beetles, common furniture beetles, skin beetles, and others, make up the superfamily Bostrichoidea. While most woodborers have a large prothorax, powderpost beetles do not, making their heads more visible. In addition to this, their antennae have two-jointed clubs.

LONGHORNED BEETLE

5. In either processed wood or rough timber, occasional holes, round or elliptical, 1/4 to 1/2 inch in diameter. Irregular and rather extensive tunnels in the sapwood with usually coarse, packed frass.

Longhorned beetles - Asian longhorned beetle, (**Anoplophora glabripennis**), also spelled Asian long-horned beetle, also called starry sky beetle, species of beetle (order Coleoptera, family Cerambycidae), originally native to eastern China and Korea, that became a serious pest of hardwood trees in North America and parts of Eurasia.

6. Usually heavy damage of this sort in finished wood. Often the only external evidence of damage is one or two oval exit holes. *Old house borer*

OLD HOUSE BORER

7. In rough, bark-covered wood, small exit holes about 1/8 inch in diameter. Inner side of bark and surface of wood itself “engraved” with galleries (old damage; can’t re-infest dried wood; no control required). *Bark beetle*

BARK BEETLE

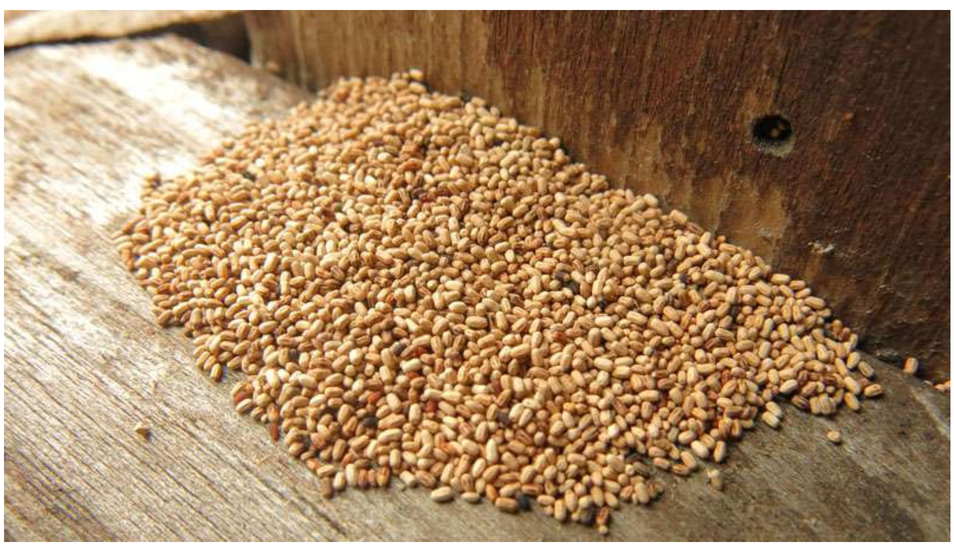
8. Pinholes and slender galleries in sapwood, frequently of southern yellow pine. The burrows and area around them stained dark by the action of fungi (old damage, can't re-infest dried wood; no control required). *Ambrosia beetle* - Ambrosia beetles are beetles of the weevil subfamilies Scolytinae and Platypodinae, which live in nutritional symbiosis with ambrosia fungi. The beetles excavate tunnels in dead or stressed trees in which they cultivate fungal gardens, their sole source of nutrition. After landing on a suitable tree, an ambrosia beetle excavates a tunnel in which it releases spores of its fungal symbiont. The fungus penetrates the plant's xylem tissue, extracts nutrients from it, and concentrates the nutrients on and near the surface of the beetle gallery. Ambrosia fungi are typically poor wood degraders, and instead utilize less demanding nutrients. The majority of ambrosia beetles colonize xylem of recently dead trees, but some attack stressed trees that are still alive, and a few species attack healthy trees. Species differ in their preference for different parts of trees, different stages of deterioration, and in the shape of their tunnels. However, the majority of ambrosia beetles are not specialized to any taxonomic group of hosts, unlike most phytophagous organisms including the closely related bark beetles. One species of ambrosia beetle, Austroplatypus incompertus exhibits eusociality, one of the few organisms outside of Hymenoptera and Isoptera to do so.

AMBROSIA BEETLE

9. No openings (or very few and these are usually sealed over). Extensive galleries run lengthwise, usually in the springwood, and are packed with a hard, mastic-like frass. May infest many old cellulose objects near or in contact with the soil. *Subterranean termites*

SUBTERRANEAN TERMITES

10. Distinct round openings to outside of wood; when split open, it reveals very thorough excavation. Galleries contain considerable amounts of coarse, hard, sandlike frass, each pellet having rounded ends and six longitudinal depressions. No mastic-like frass or very fine powder. *Drywood termites*



DRYWOOD TERMITE FRASS

CARPENTER ANTS

11. Timbers with extensive galleries that are sandpaper smooth, often with rounded edges, and contain no frass. Coarse sawdust may be found near damage. *Carpenter ants*

CARPENTER BEE AND DAMAGE

12. Wood with 1/3- to 1/2-inch round holes on side, edge or end, leading into long tunnel (3 to 24 inches). If hole is on side of wood, tunnel turns at right angles and continues with the grain of the wood. *Carpenter bees*

Adapted from a release by Department of Entomology, Purdue University, West Lafayette, Ind.

Wood Destroying Birds

Woodpecker

There are many varieties of woodpeckers all across North America. While there are common characteristics the birds of the woodpecker family share, each species can be quite unique! They range from small to large and plain to colorful. Woodpeckers are known for their powerful beaks, long tongues, sometimes flashy colors, and their excellent climbing skills. There are over 200 types of woodpeckers in the world and at least 20 species in North America.

Woodpeckers are classified as migratory, nongame birds and are protected by the federal Migratory Bird Treaty Act, which means that they can't just be removed like any other pest. Permits are required for the use of traps, and a licensed pest control expert will have to take care of the removal. Furthermore, two woodpecker species – the red-cockaded woodpecker and the ivory-billed woodpecker – are on the Endangered Species list.

"A bird management professional can apply a repellent product in the holes that will discourage the woodpecker from returning there," says **Kim Lewis**, division manager of bird management services at Rentokil Steritech, which provides residential and commercial pest control services.

Crazy Corn
There was a time that we could easily fed these birds "crazy corn" but those days are gone. Crazy corn and similar products are not "lethal" but these are hypnotics to hallucinogenics, therefore these products unintentionally lead the birds' death. The birds will either "sleep" or fly into buildings and get injured, therefore dying as a secondary process of the corn. These type of products are commonly used on other bird pests like pigeons and waterfowl. Most of the birds that "sleep" are often fed to captive "wild" animals at zoos.

Wild Parrots

LEFT SIDE RED-LOREN AMAZON PARROT, RIGHT SIDE – ROSE RINGED PARAKEET - COMMON IN CALIFORNIA - FLORIDA

The red-lored amazon or red-lored parrot (Amazona autumnalis) is a species of amazon parrot, native to tropical regions of the Americas, from eastern Mexico south to Ecuador where it occurs in humid evergreen to semi-deciduous forests up to 3,300 feet altitude. Wild parrots wood damage is the easiest damage to determine.

Wild parrots are an imported species gone wild. They appear to be thriving, with the way they're reproducing and squawking all over the region, but how is that possible when they came from the moist jungle? How have any parrots managed to survive in the wild at all, much less reproduce enough to be considered invasive, in an environment so different from their own?

The term "invasive species" includes both conditions of non-native origin and displacement, meaning that the species comes from a foreign environment and is driving out native birds with its living habits. The origins of parrots in California, Nevada, Arizona, Texas to Florida are pet owners and humane centers that release these birds due to the inability to care or not enough resources for keeping these animals. These birds will out life their pet owners and their children. Most animal rescue centers (humane centers) release birds once the animal is healthy enough to be released no matter of the species, including all species of parrots.

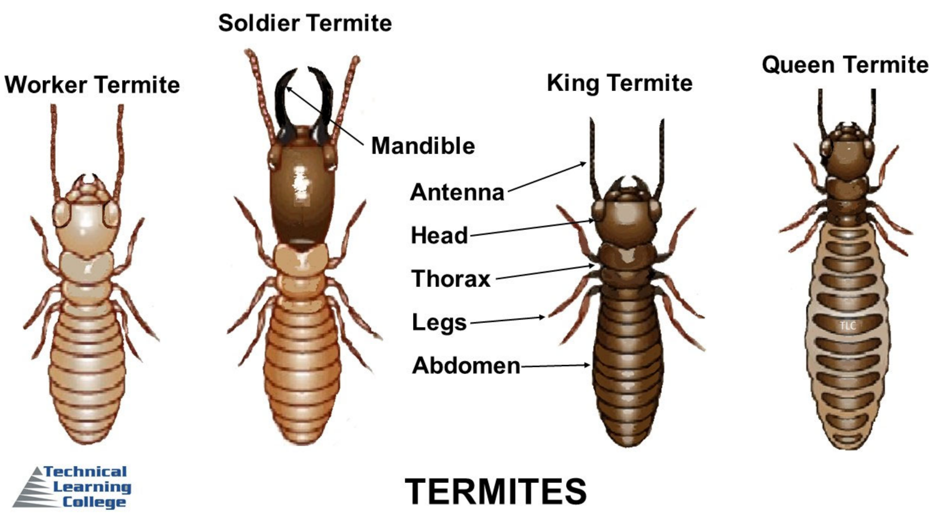
Because woodpeckers and parrots are beloved birds and are proper identification and control is a hot topic, a federal, and/or state permit is necessary to control, trap or re-locate these pests. The proper identification is very difficult and may require additional experts.

Wood Destroying Insects – Specific Damage

Termite Damage Introduction

Many insect pests are encouraged to take up residence in wooden structures by excessive moisture conditions. Termites, particularly the dampwood termites and subterranean termites, require moisture in their living quarters. Subterranean termites provide moisture for themselves by bringing moisture and soil up from their subsurface colonies and placing it within the wood as they feed on it or around the outside of wood to form their enclosed runways. In some cases, subterranean termites may be found separated from soil contact when sufficient moisture, in the form of water leaks, is found inside a structure.

The retention of moisture is not the only important water-related factor in the life of the termite. The warm, moist conditions that prevail within the closed system of the nest provide an ideal site for the growth of microorganisms, particularly fungi, which provide a source of protein and vitamins essential to the termite.



The accumulation of termite fecal material in the nest, in turn, helps to promote the growth of the fungi. The most striking fact of this intricately interdependent system is the delicacy with which it is balanced. It is not uncommon to discover the remains of a termite colony that is slowly being crowded out by the growth of fungi that has for some reason progressed at such a rate that the termites could not keep up with it. If sudden temperature shifts or other factors result in the accumulation of water within the galleries, the termites may drown. A number of beetles are associated with excessive moisture and fungus problems in structures.

Beetle Damage

The furniture beetle, an anobiid beetle, is commonly attracted to moisture and fungus. Anobiid larvae eat the wood, and the beetle may re-infest over many generations, reducing the wood to little more than powder. Anobiid larvae will not survive in wood with a moisture content below 12 percent. The drier the wood, the slower their growth.

Other families of beetles are also associated with excessive moisture in structures, but with all these families, it is the fungus growth to which they are attracted.

POWERPOST BEETLE DAMAGE

WOOD BORERS DAMAGE
BASEBAT BAT

Subterranean Termite Damage Recognition

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 foamboard. According to some research, a colony containing 60,000 workers could consume the equivalent of one foot of a 2" x 4" piece of lumber in slightly over 5 months.

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. Alates 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.

Termites Galleries Differences

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

When inspecting for termites, it is useful to probe wood with a knife or flat blade screwdriver to detect areas that have been hollowed. Severely damaged wood may have a hollow sound when it is tapped.

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.

WINGED TERMITE

Mass Emergence
The mass emergence of winged termites in the spring is often the first sign of an infestation. In the majority of cases, they emerge in homes near sources of heat - furnaces or water heaters. The appearance of winged termites means that the infestation has been around for at least 3 or 4 years. Therefore it is likely some damage has already been done, so it is important to find where the termites have been feeding, how much damage has been done, and how much repair is needed.

A qualified professional termite control service should be hired to apply an appropriate termiticide to protect the building from further damage. Other means of detecting infestations include knocking on walls, floors, sub-floor wood, joists, etc. and listening for the tapping of soldiers, and looking for shelter tubes on the outside of the building and under the sub-floor.

Because subterranean termites have a constant demand for water, one should closely examine areas near moist soil, such as below dripping outside faucets, leaking underground sprinkler pipes and nozzles, and below downspouts.

Where damage or termites are suspected, prod with a sharp narrow implement to check the soundness of the supporting wood structure. The detection of termite infestations is best left to professionals who have the experience to do it thoroughly and accurately. Termites can enter a building from one or more points so it is important to locate all points of entry for control purposes.

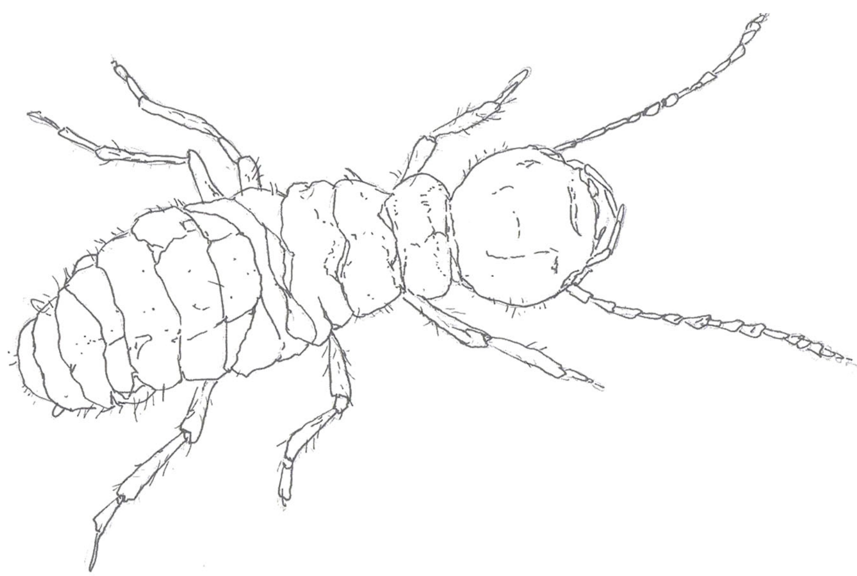
Outdoors, termites can be detected by driving wooden stakes into the ground at varying distances from buildings and other wooden structures. Examine the stakes every 3 months for termites or signs of their feeding damage.

Evidence of Termite Infestations

1. Wood damaged by subterranean termites can be readily penetrated with a screwdriver, ice pick, or knife. The wood easily breaks apart, revealing mud tubes attached to wood galleries or tunnels in an irregular pattern. The tunnels may contain broken mud particles with fecal materials. In the case of an active colony, white termites may be found in infested wood.

2. The presence of winged males, females, or their shed wings, particularly when the adults fly inside the building, indicates an infestation in the building.

3. Another indication is the presence of mud or shelter tubes extending from the ground to woodwork or on foundation walls. Workers travel periodically via shelter tubes to their colony to obtain moisture and perform feeding duties. Workers build mud or shelter tubes from soil and wood particles, and coat them with a glue-like substance that they secrete. Each mud tube is about the diameter of a lead pencil.



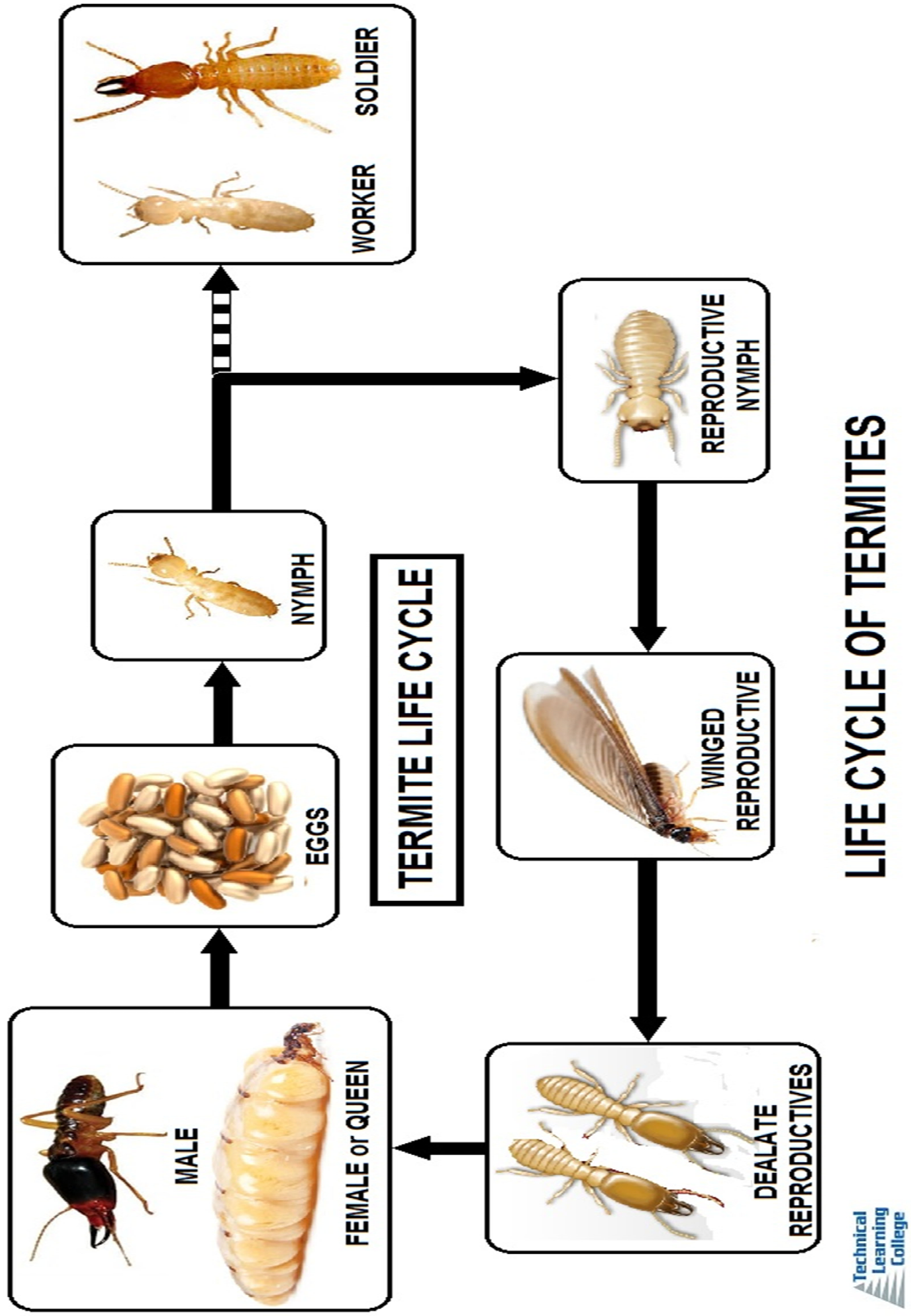
SUBTERRANEAN FORMOSAN TERMITE

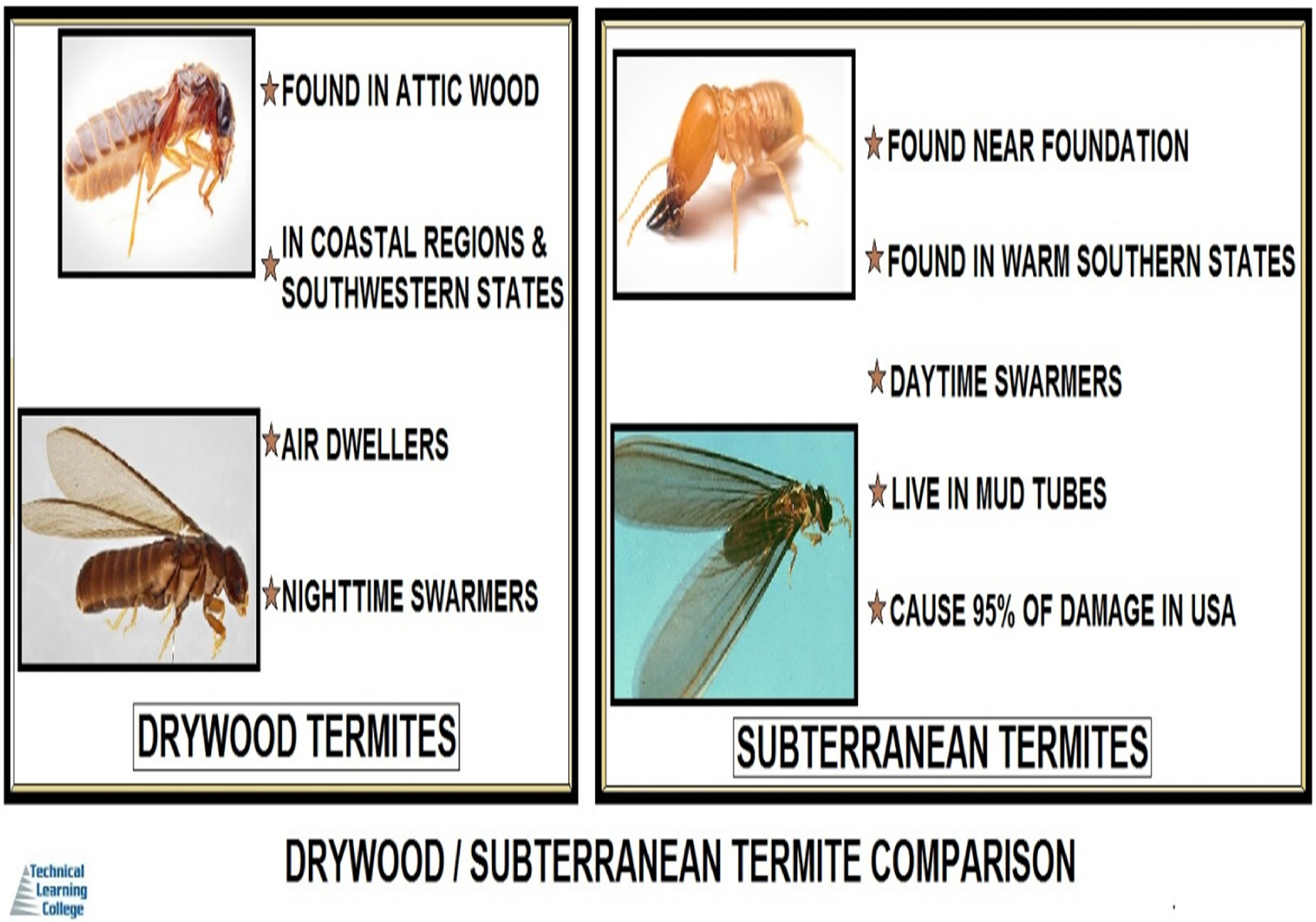
How Old is the Damage?

Based on normal feeding activity, it takes 3 to 8 years to cause appreciable damage to a structure. There have been some predictions that, under ideal conditions, a termite colony of 60,000 workers may consume a one-foot length of 2" x 4" pine in 118 to 157 days. In the United States, the extent of damage may be less because of a reduction in feeding activity during the cold season.

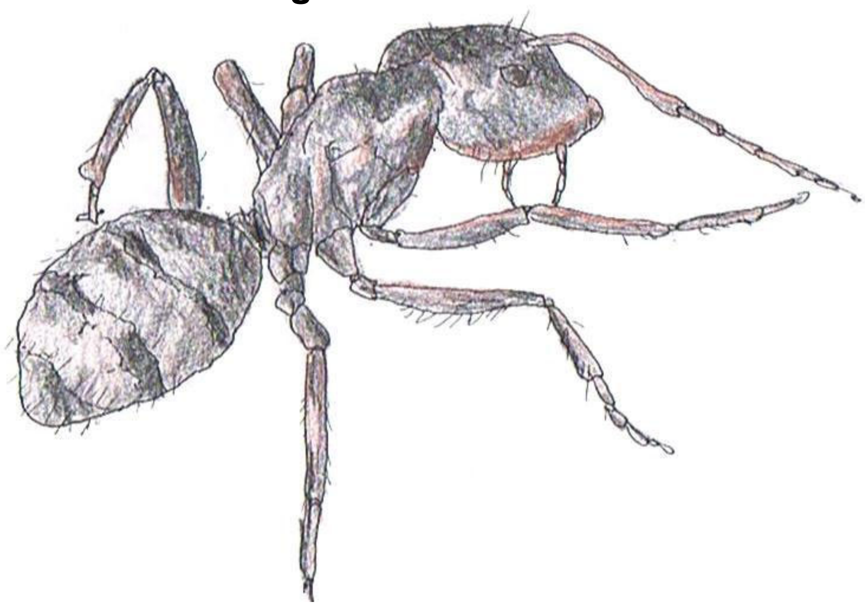
Probing interior trim wood reveals termite damage.

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.


LIFE CYCLE OF TERMITES
TERMITE LIFE CYCLE
MALE
FEMALE or QUEEN
EGGS
NYMPH
WORKER
SOLDIER
REPRODUCTIVE NYMPH
WINGED REPRODUCTIVE
DEALATE REPRODUCTIVES
Technical Learning College


★FOUND IN ATTIC WOOD
★IN COASTAL REGIONS & SOUTHWESTERN STATES
★AIR DWELLERS
★NIGHTTIME SWARMERS
DRYWOOD TERMITES
★FOUND NEAR FOUNDATION
★FOUND IN WARM SOUTHERN STATES
★DAYTIME SWARMERS
★LIVE IN MUD TUBES
★CAUSE 95% OF DAMAGE IN USA
SUBTERRANEAN TERMITES
DRYWOOD / SUBTERRANEAN TERMITE COMPARISON
Technical Learning College

Black Carpenter Ant Damage



Black Carpenter Ants

Ants of the genus Camponotus often nest in wood. There are many different carpenter ant species, but only one poses a major pest problem (the black carpenter ant (Camponotus pennsylvanicus). The black carpenter ant varies from 1/8 to 1/2 inch in Length because of the presence in most colonies of both “major” and “minor” workers. Carpenter ants may construct their nests in hollow trees, logs, posts, porch pillars, hollow doors, and other timbers used in homes. The ants do not consume the wood but simply hollow it out to form cavities for the nest. They are usually attracted to damp, decaying wood, but once the nest is started, they will also excavate sound wood as they enlarge the nest.

It is often quite common to find them nesting in existing voids that require no excavation; occasionally they start in an existing void and enlarge it as their need dictates. The presence of carpenter ants suggests the potential for damage to wood.

Biology

Carpenter ants are among the largest species that you’ll find. Like other ant species, carpenter ants are social, i.e., they live in a colony and have several "castes" or adult forms that perform different jobs in the colony. The queen usually reaches 9/16 inch in length. The workers range in size from 1/4 to 7/16 inch. So, if you see different sized ants, they could all be from the same colony. All of these ants are adults regardless of their size, so they do not grow. Only the queen produces offspring in the nest. Immature ants (larvae) are white, legless, and maggot-looking in appearance. They remain in the nest and are fed by the workers.

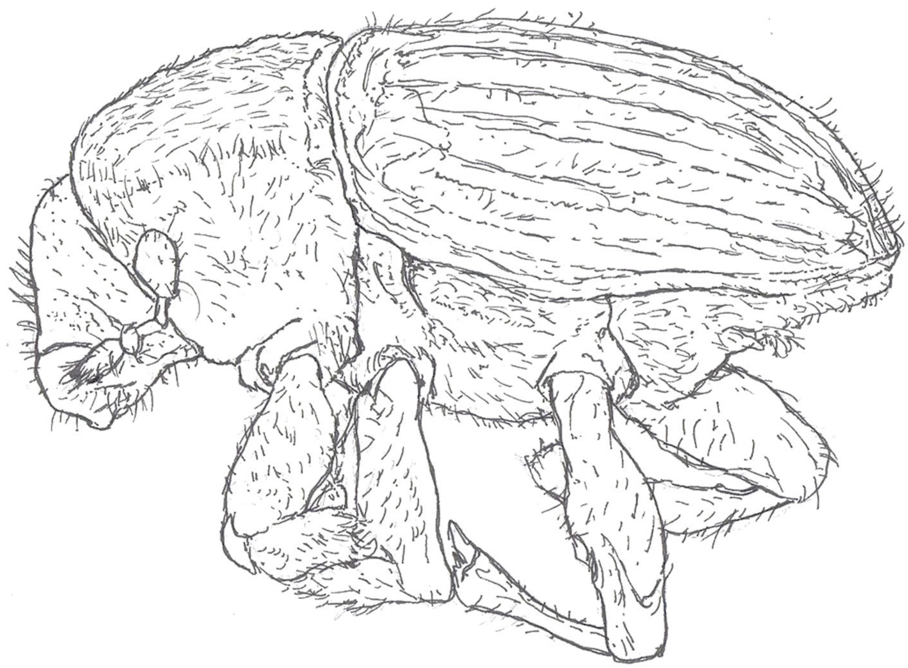
The larvae develop into pupae, which are tan and capsule-shaped. Eventually, new adults emerge from these pupae. Adult ants will vary in color depending upon the species. The black carpenter ant, the species that most commonly nests in homes, is primarily black in color. Other carpenter ant species may be more reddish-brown to yellow in color.

Life Cycle
In the spring, carpenter ants swarm, i.e., winged adults emerge from the colony. The swarmer's sole purpose is reproduction. Shortly after mating, the female (queen) loses her wings and searches out a cavity in wood or soil where she begins to lay eggs and produce her colony's first workers.

These workers care for the queen as she produces more offspring, and they assume the tasks of foraging for food, maintaining and expanding the nest, and caring for the young. After 3-6 years, the colony will contain 2000-3000 workers, and will start to produce swarmers.

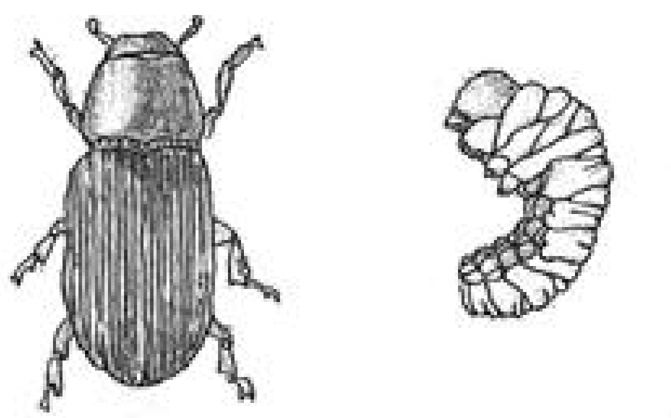
The swarmers are actually produced in the fall, but they wait until the following spring to emerge. Swarming is not the only means for carpenter ants to produce new nests. "Satellite" colonies may be formed by workers that move out of the main nest, carrying larvae and pupae with them. Eventually, these secondary colonies produce their own reproductives.

Wood Borers Insect Identification- Diagrams

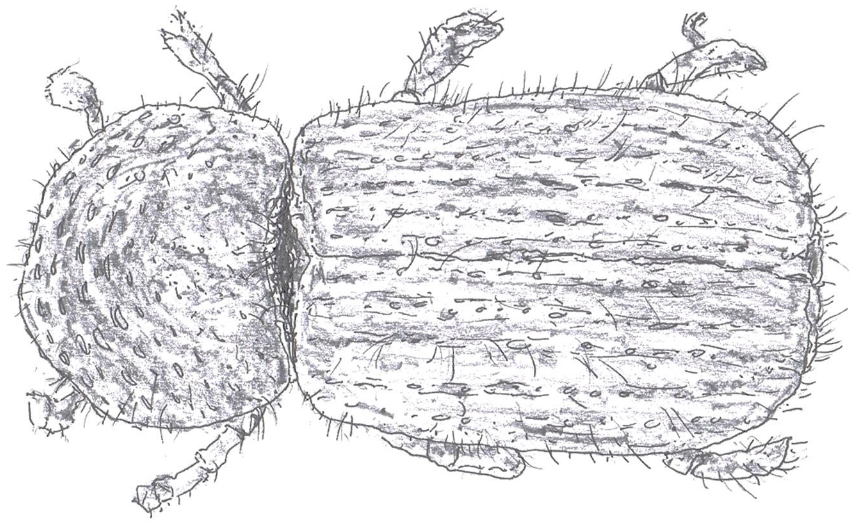


BARK BEETLE (ADULT)

Bark beetle adult
Although not true borers, bark beetles attack several evergreen trees. The adults usually emerge in mid-summer and lay eggs.

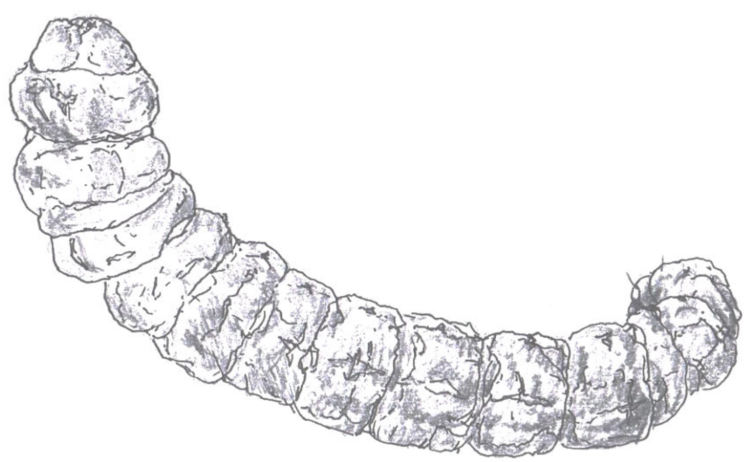


Bark beetle larvae
The larvae are legless grubs that feed just under the bark. Enough larvae can girdle a tree. In affected trees, the tops turn red then yellow and brown. Different species can be determined by the shape of the gallery in some cases.



SHOT HOLE BORER (ADULT)

Shot-hole borer adult
Shot hole borers attack weakened or dead trees and shrubs. They feed deeper in the wood than bark beetles. The larvae are legless grubs. Many emergence holes are often present where several adults have emerged. Thus, the "*shot hole*" appearance on affected trees.

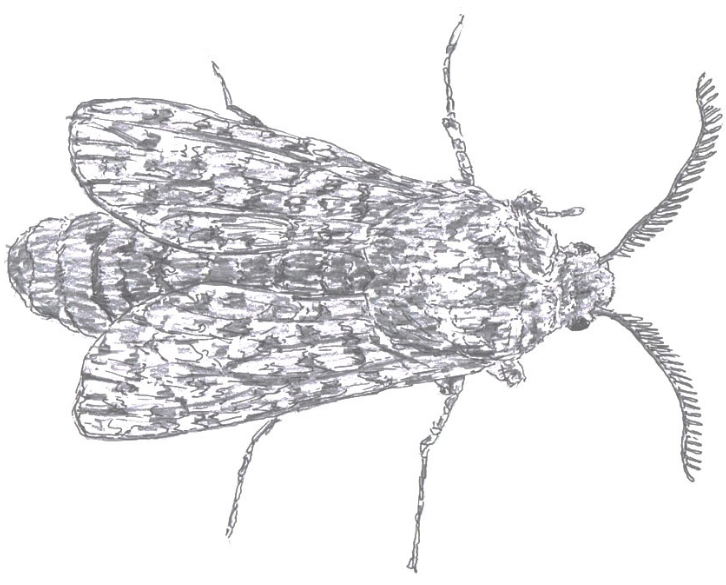


CARPENTER WORM LARVAE

Carpenter worm larva
Carpenter worms are large caterpillars that grow to almost three inches long. They mine the heart wood of trees. They attack poplars and cottonwoods and can attack many other trees as well.

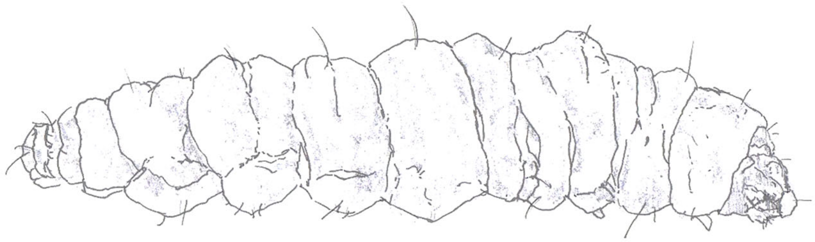
CARPENTER WORM MOTH (ADULT)

Carpenter worm adult
The adult carpenter worm is a large grey moth.



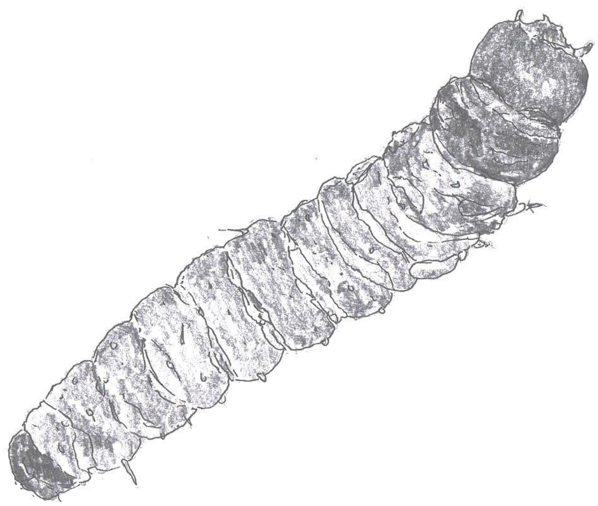
CLEAR WINGED MOTH

Clear-winged moth adult
Many clear-winged moths bore in trees as larvae. The adults resemble wasps in many cases.



CLEAR WINGED MOTH LARVAE

Clear-winged moth larva
The caterpillars of clear-winged moths can extensively mine limbs of susceptible trees. Poplars, willow, and cottonwood trees are hosts of several species.



PEACH TWIG BORER (LARVAE)

Peach twig borer larva
The peach twig borer is a pest because it mines in the ends of the new twigs of fruit trees and ornamental fruit trees. The new twigs start to grow and then wilt because these larvae are tunneling down the center of them. Adults are small grey moths.

Borers are a major problem for ornamental trees. Once infested, there is little that can be done to control the insects in the wood. Thus, keeping trees as healthy as possible is the best way to prevent borer damage.

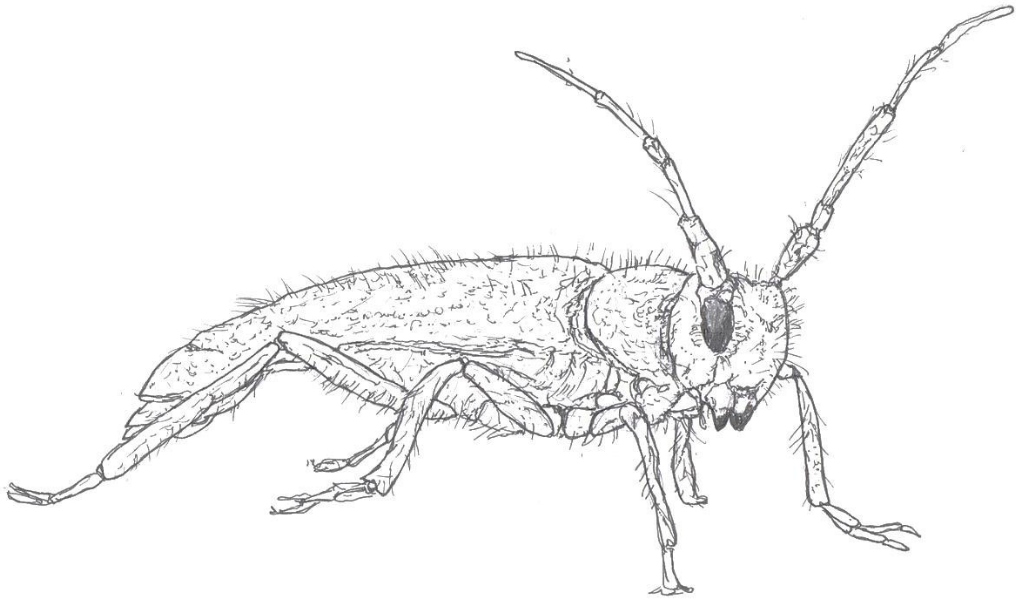
Trees that are old, drought stressed or otherwise unthrifty are most likely to be successfully attacked by borers. Most of the borers we encounter are beetles but some are caterpillars of clear winged or other moths and others are primitive wasps.

POPLAR & WILLOW BORER (ADULT)

Poplar and willow borer adult
These weevils emerge around August and lay eggs in stems at least 1" in diameter. It does not attack quaking aspen but a similar borer does.

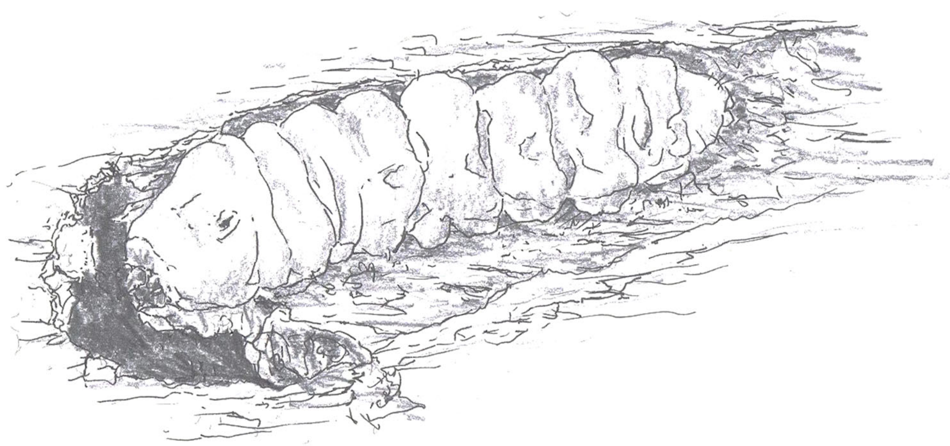
POLAR BORER (LARVAE)

Poplar and willow borer larva
The larvae mine the sapwood. Swollen areas on limbs show where the larvae feed and frass can be seen being forced out of holes in the bark as the larva feeds.



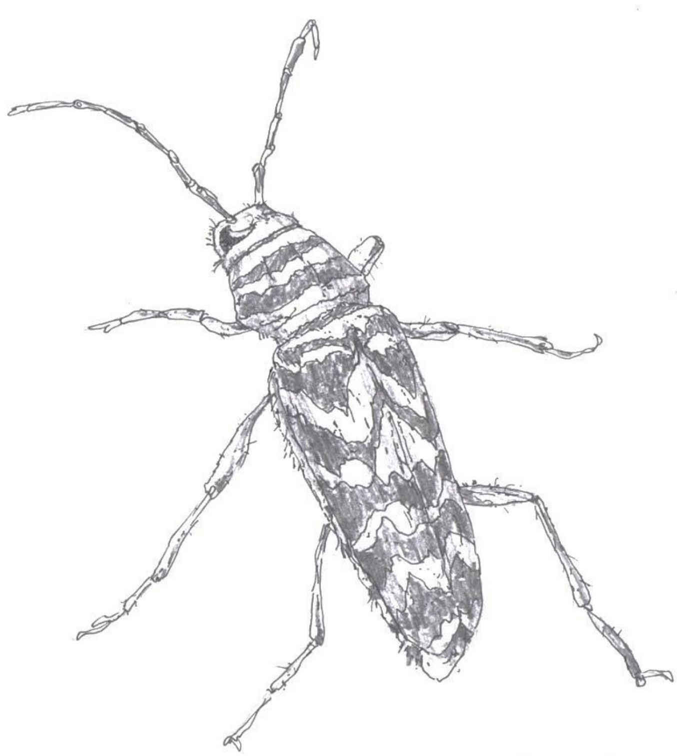
POPLAR BORER (ADULT)

Poplar borer adult
Poplar borers are a serious pest of poplar. Adults emerge and are around from June through August.



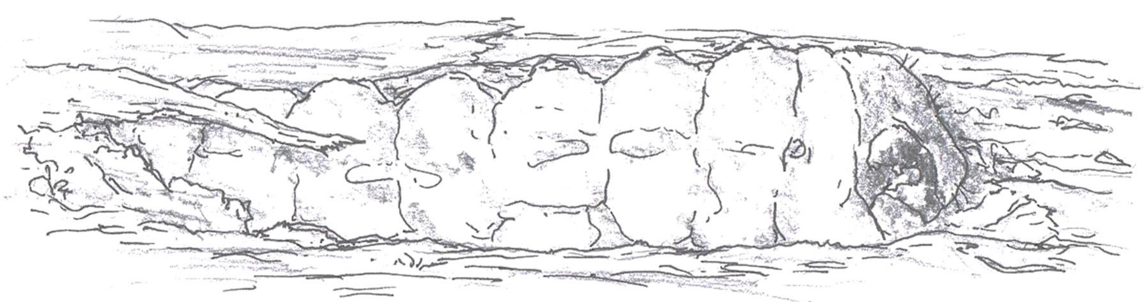
POPLAR BORER LARVAE AND DAMAGE

Poplar borer larva
Most of the life cycle is spent as the larva in the tree. They feed for a period of 2-4 years and bore in the heartwood and sapwood. Infested trees can be weakened and break. A related species causes galls on smaller limbs of poplars and aspens.



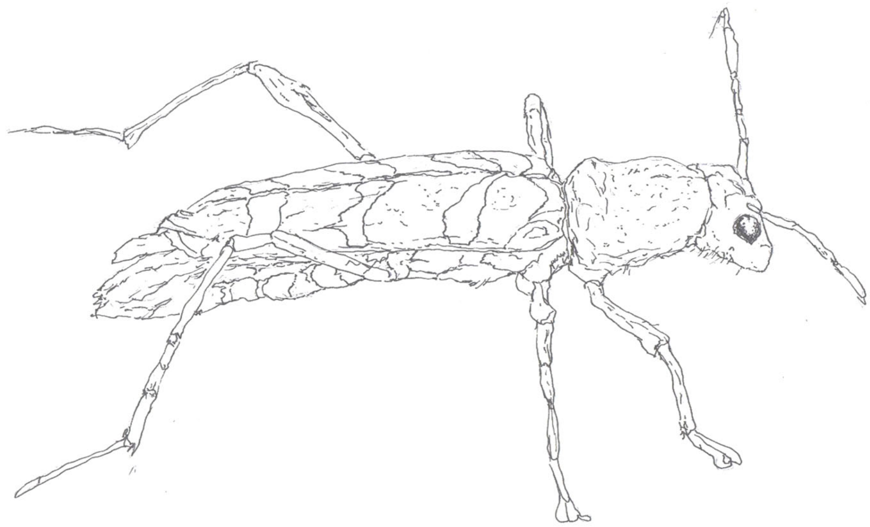
LOCUST BORER (ADULT)

Locust borer adult
Locust borers attack black locust trees. The strikingly colored adults emerge in the fall and can be seen feeding on goldenrod.



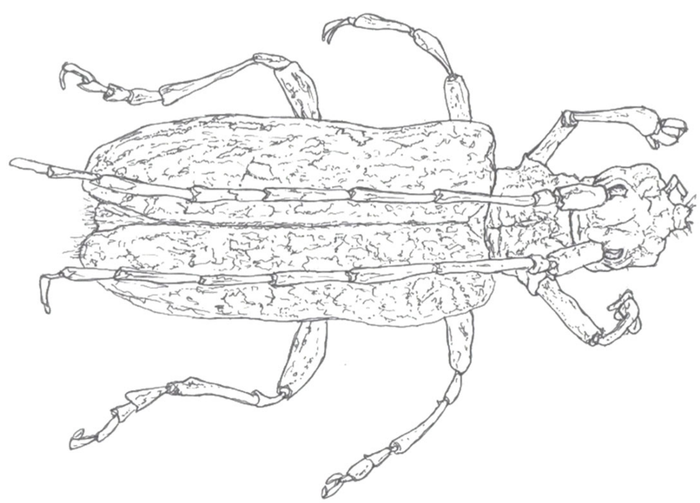
LOCUST BORER LARVAE AND DAMAGE

Locust borer larva
A year is required for the larva to develop in the locust tree. Severe damage can occur from the larval feeding.



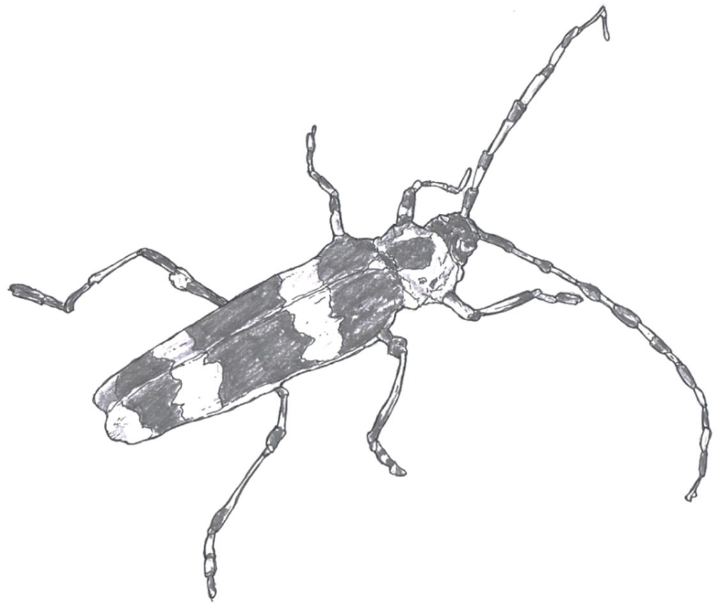
RED HEADED ASH BORER (ADULT)

Red headed ash borer adult
The red headed ash borer commonly infests ash. The larvae look like those of the locust borer only smaller. It will attack elm, linden, redbud, and oak as well as ash trees.



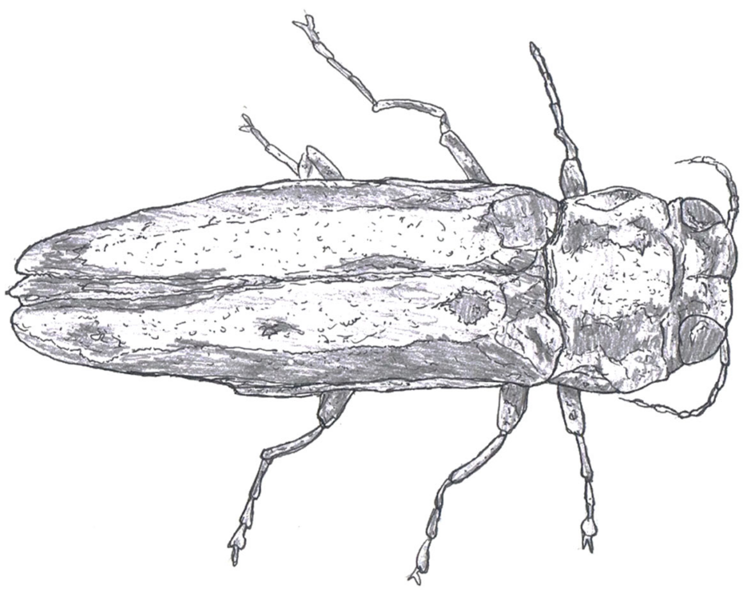
PINE SAWYER (ADULT)

Pine sawyer adult
Pine sawyers attack pine trees and are usually found around homes as a result of being brought in with firewood. They seldom attack pine trees in residential plantings.



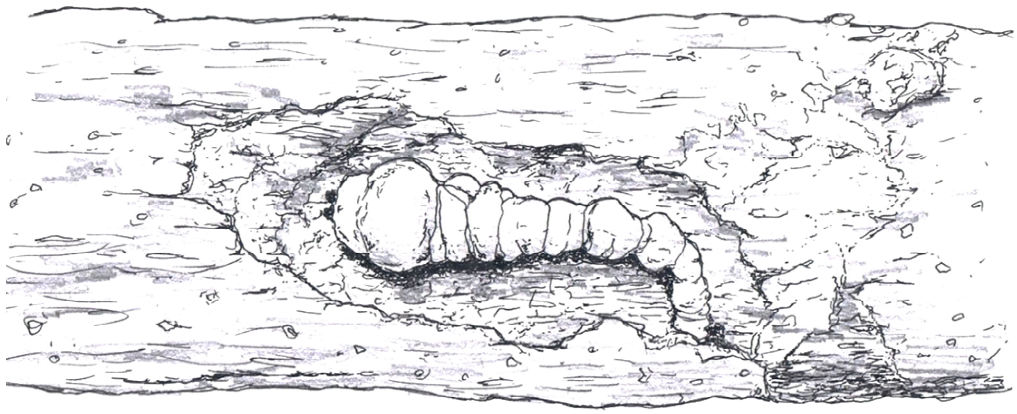
CALIFORNIA LAUREL BORER (ADULT)

California laurel borer adult
This striking insect, the California laurel borer, mines in dead ash, laurel, and willow. It is not a threat to healthy trees.



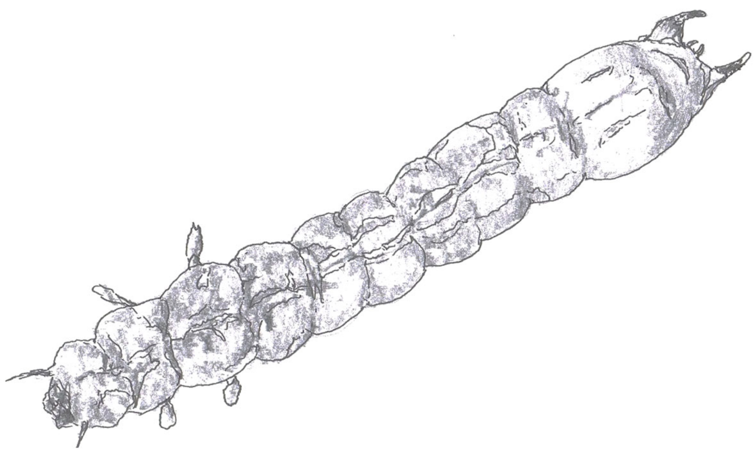
BRONZE BIRCH BORER (ADULT)

Bronze birch borer adult
Paper birches are frequently attacked by the bronze birch borer. Adults emerge in June and lay eggs in July. Note they have shorter antennae and a different shape than the borers discussed above.



BRONZE BIRCH BORER LARVAE

Bronze birch borer larva in limb
Most of the two-year life cycle is spent in the larval stage tunneling in the wood of birch trees. The larvae have a flattened area just behind the head which is characteristic of the flat headed borers. Damage symptoms are usually expressed by some upper limbs of the tree turning yellow and then dying.

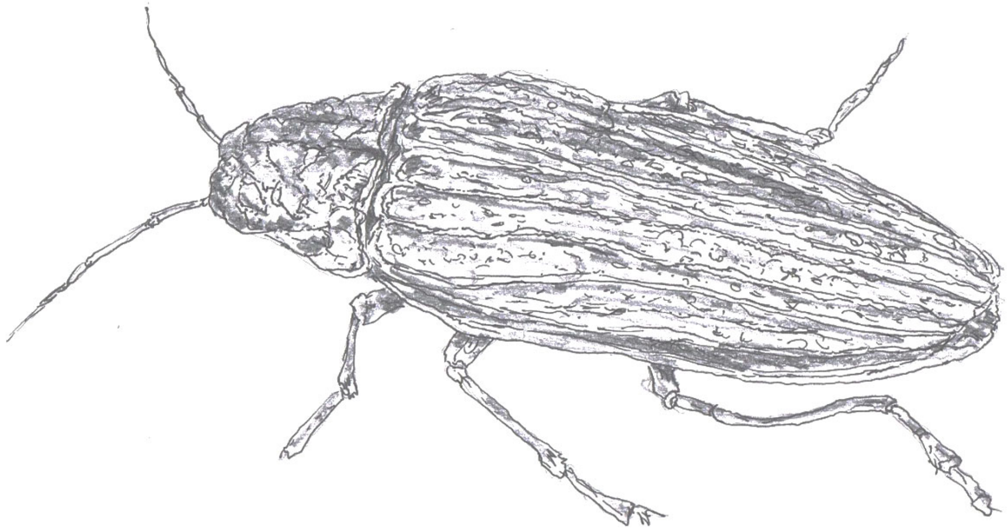


BARK BEETLE LARVAE

Larvae: small, cream-colored grubs. Larvae can be found feeding in galleries in the inner bark.

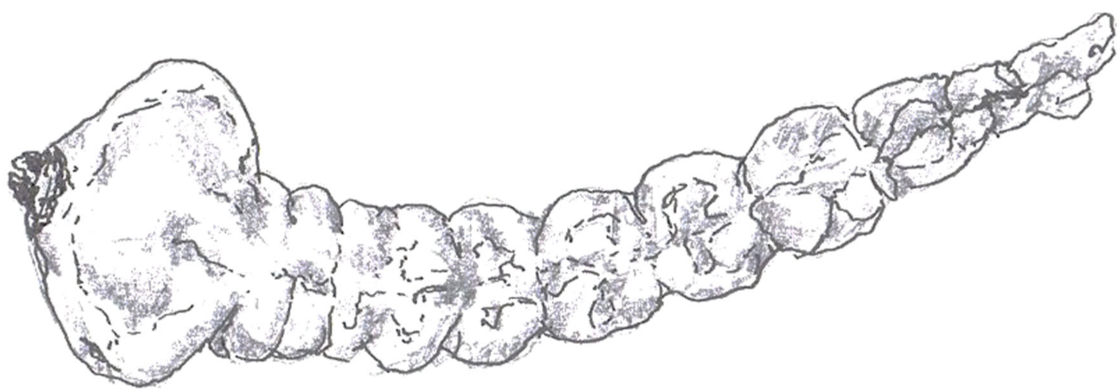
Galleries: Y- or X-shaped tunnels beneath the bark. Larvae, pupae, and adults can be found in the galleries during the growing season. Galleries are empty during the late fall, winter, and early spring.

Exit holes: small, round holes in the outer bark created by adults exiting the tree. Due to an abundance of exit holes, a tree that has died from bark beetle attack looks as if someone shot it with a shotgun.



PACIFIC FLATHEAD BORER (ADULT)

Pacific flatheaded borer adult
There are about 100 species of flatheaded borers represented here by the pacific flatheaded borer. This insect attacks many fruit and ornamental trees and shrubs.



PACIFIC FLATHEAD BORER LARVAE

Pacific flatheaded borer larva
Borers of this type have the typical larval shaped pictured here.

CARPENTER BEE

Carpenter Bees
The carpenter bee (Xylocopa virginica) resembles a bumblebee in that it is robust and black with some markings of yellow hair. The dorsal surface of the abdomen lacks the yellow hair markings of bumblebees and is mostly devoid of any hair. These bees are considered pests of wood because they excavate tunnels in softwood as sites for producing their brood. Common nesting sites are posts, fence railings, porch support posts, wall siding, eaves, wooden shingles, windowsills, doors, wooden porch furniture, etc.

Wood Wasp
The wood wasp's life cycle begins with a fertile female adult drilling into the tree's bark and then using her ovipositor to lay eggs. When the eggs hatch, the wasp larvae bore further into the tree, living there for as long as 2-3 years. When the insect's pupal stage is complete, adult wasps emerge after chewing through as much as an inch of wood and bark.

Wood Destroying Beetle Sub-Section

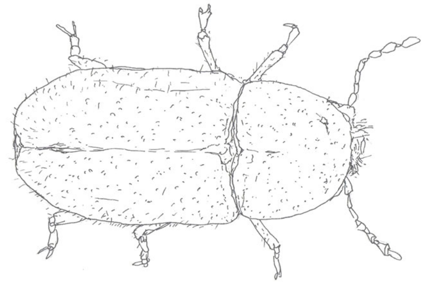
Many insect pests are encouraged to take up residence in wooden structures by excessive moisture conditions. Termites particularly - the dampwood termites and subterranean termites, require moisture in their living quarters. Subterranean termites provide moisture for themselves by bringing moisture and soil up from their subsurface colonies and placing it within the wood as they feed on it or around the outside of wood to form their enclosed runways. In some cases, subterranean termites may be found separated from soil contact when sufficient moisture, in the form of water leaks, is found inside a structure.

The retention of moisture is not the only important water-related factor in the life of the termite. The warm, moist conditions that prevail within the closed system of the nest provide an ideal site for the growth of microorganisms, particularly fungi, which provide a source of protein and vitamins essential to the termite.

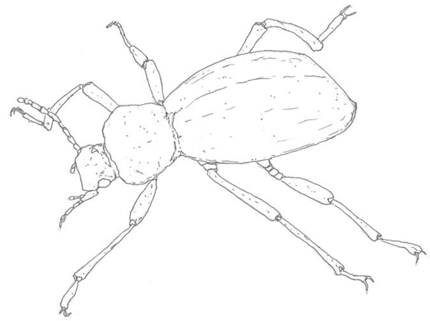
ANOBIID POWDERPOST BEETLE

The accumulation of termite fecal material in the nest, in turn, helps to promote the growth of the fungi. The most striking fact of this intricately interdependent system is the delicacy with which it is balanced. It is not uncommon to discover the remains of a termite colony that is slowly being crowded out by the growth of fungi that has for some reason progressed at such a rate that the termites could not keep up with it. If sudden temperature shifts or other factors result in the accumulation of water within the galleries, the termites may drown. A number of beetles are associated with excessive moisture and fungus problems in structures.

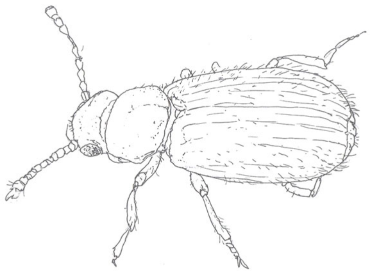
The furniture beetle, an anobiid beetle, is commonly attracted to moisture and fungus. Anobiid larvae eat the wood, and the beetle may re-infest over many generations, reducing the wood to little more than powder. Anobiid larvae will not survive in wood with a moisture content below 12 percent. The drier the wood, the slower their growth. Other families of beetles are also associated with excessive moisture in structures, but with all these families, it is the fungus growth to which they are attracted.



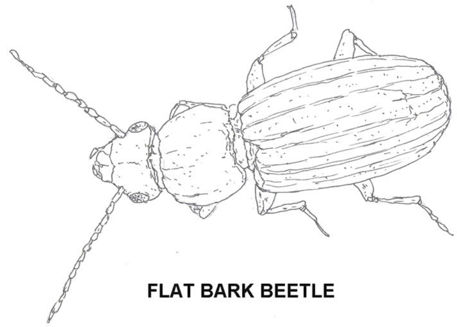
MINUTE FUNGUS BEETLE



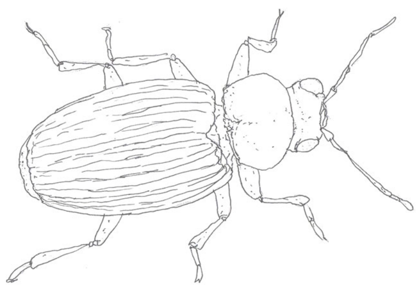
DARKLING BEETLE



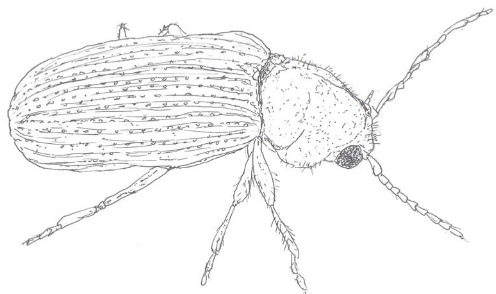
SILKEN FUNGUS BEETLE



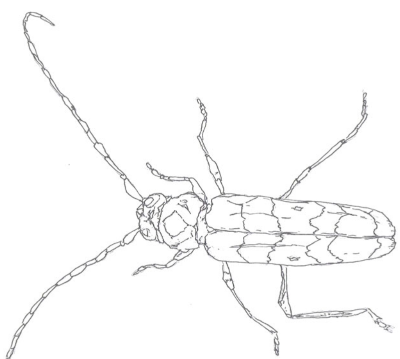
FLAT BARK BEETLE



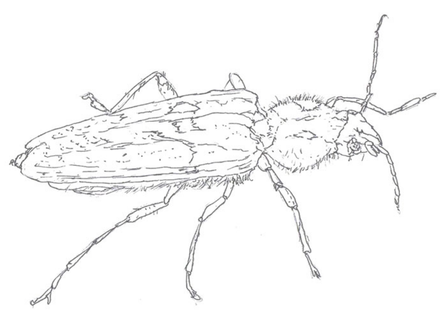
MINUTE BROWN SCAVENGER BEETLE



DEATHWATCH BEETLE

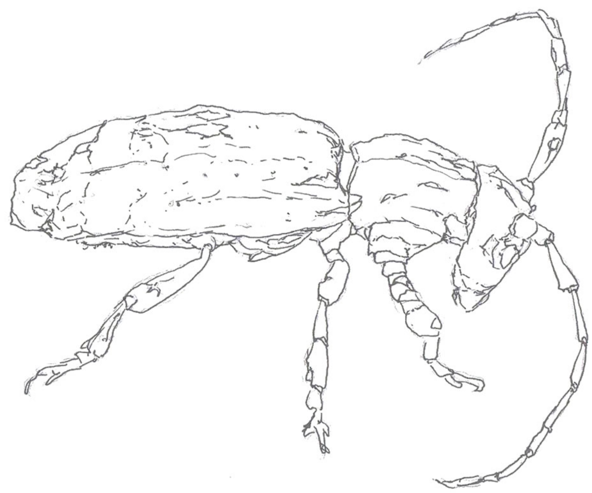


BANDED ALDER BORER

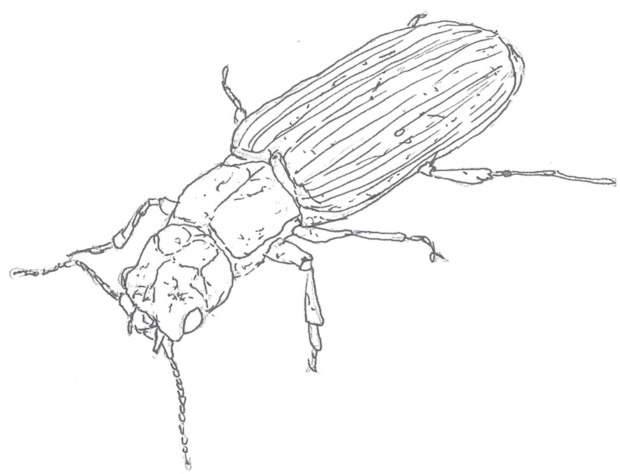


OLD HOUSE BORER BEETLE

Powder Post Beetles

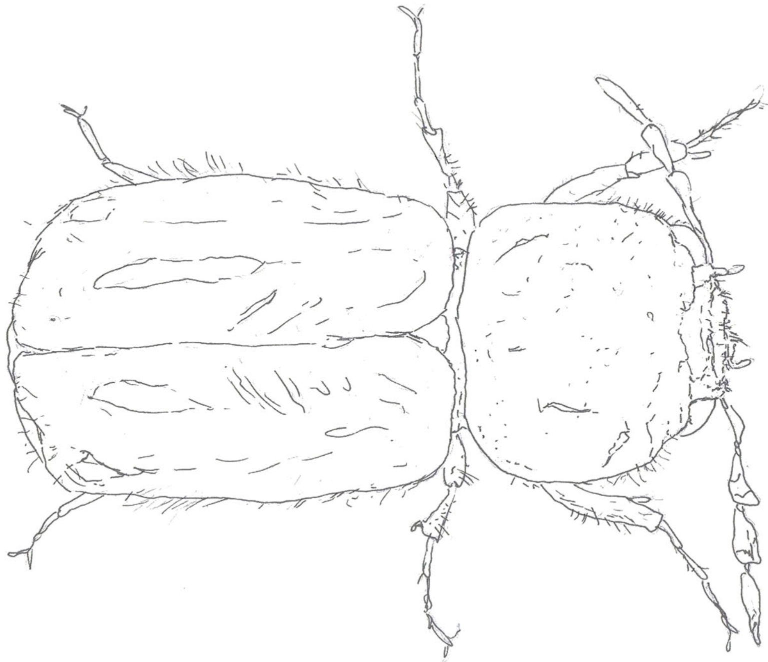


CERAMBYCID POWDERPOST BEETLE



LYCTID POWDERPOST BEETLE

Powder Post Beetles
The term powder post beetle, used in the broad sense, applies to any of the wood-boring species of three closely related families (Lyctidae, Bostrichidae, and Anobiidae) within the superfamily Bostrichoidea. The common name is appropriate because the larvae of these beetles reduce timbers to a mass of very fine, powderlike material. The adults do very little actual damage to wood, serving primarily a reproductive function. There are certain differences in structure, behavior, and nutrition among these groups, and these differences have led to the separation of the families.

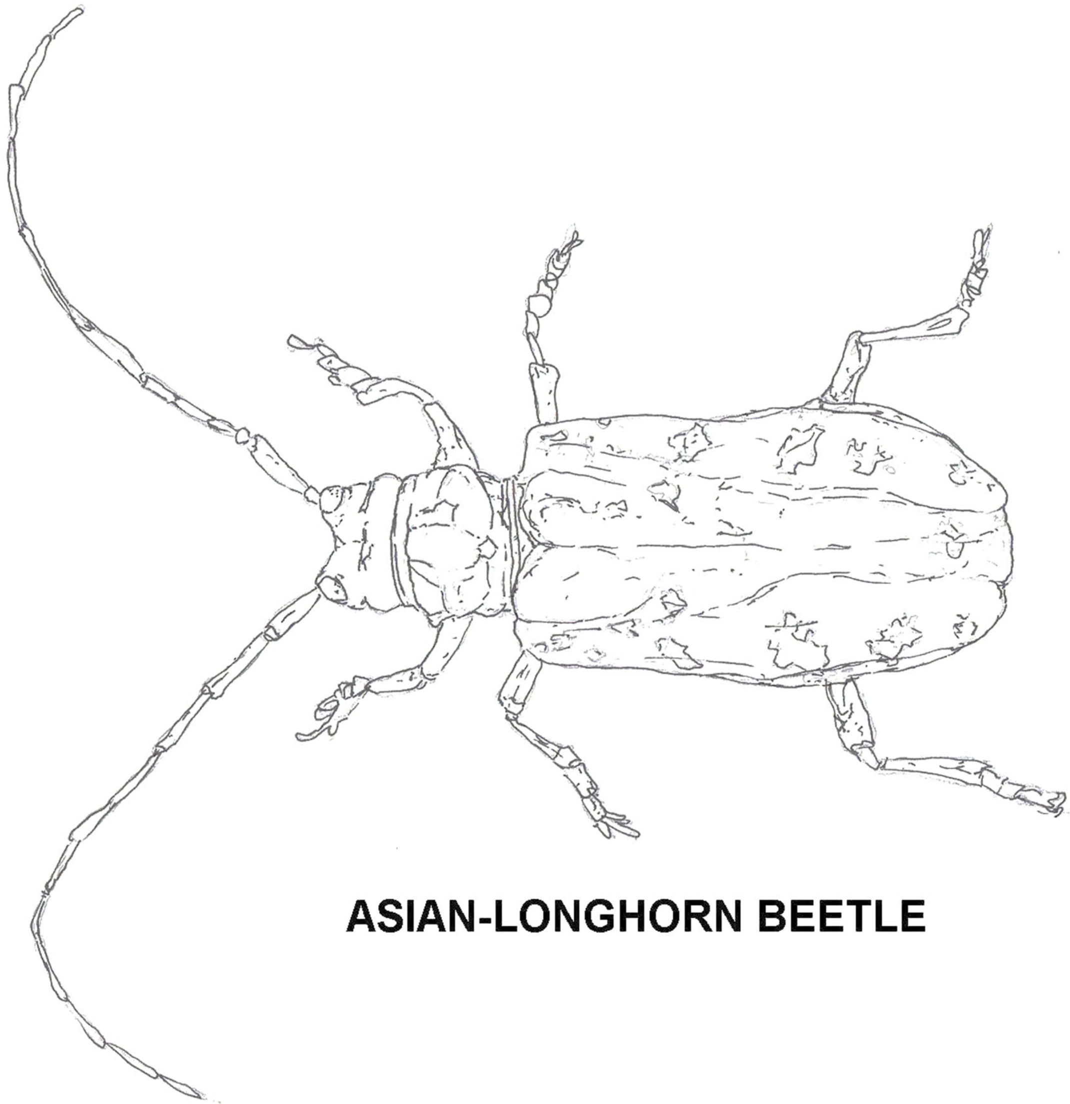


BOSTRICHID POWDERPOST BEETLE

The Bostrichidae are a family of beetles with more than 700 described species. They are commonly called auger beetles, false powderpost beetles, or horned powderpost beetles. The head of most auger beetles cannot be seen from above, as it is downwardly directed and hidden by the thorax. Exceptions are the powderpost beetles (subfamily Lyctinae), and members of the subfamily Psoinae.

Damage by Common Wood-Boring Beetles

Insect Type	Wood Type	Shape & Size of holes	Reinfestationsb
Anobiid Beetles	Soft & Hard	Round 1/16″ – 1/8″	Yes
Bostrichid Beetles	**Soft & Hard**	**Round 3/32″ – 9/32″**	**Rarely**
Lyctid Beetles	Hard	Round 1/32″ – 1/16″	Yes
Old House Borer	Soft	Oval 1/4″ – 3/8″	Yes



ASIAN-LONGHORN BEETLE

Longhorned Beetles

Longhorned beetles are large (1/2 to 3 inches long), conspicuous beetles with long, thin antennae that may be longer than their bodies. They usually lay their eggs on unseasoned, rough-sawn timbers or logs. The larvae, called roundheaded borers, feed in the wood, boring large, oval-shaped holes as they move through it. Infestation usually takes place before the timber is used in structures. The larvae of some species take more than one year to complete their development, so they may still be feeding in the wood after it becomes part of a structure. Damage is usually limited to pine sapwood and can be recognized by the ripples on the surface of the galleries.

The adult beetle will not lay eggs for re-infestation on this type of wood, so control is rarely called for. However, the exception to this is a species known as the old house borer (Hylotrupes bajulus). Old house borers will attack timbers in a building, so they are the only longhorned beetles requiring control measures. The adult is about 3/4 inch long and grayish brown to black with two white patches on its wing covers.

Fungus Beetles

- Cisidae—the minute fungus beetles.
- Cryptophagidae—the silken fungus beetles.
- Lathridiidae—minute brown scavenger beetles.
- Tenebriodiae—darkling beetles.
- Cucujidae—flat bark beetles.

These beetles and their larvae feed on fungus growth on wood, such as Poria, or may be present in damp foods where even tiny amounts of fungus growth or fungal spores are present. The fungus beetles are not wood-damaging pests but are associated with moisture problems and are a good indication that such problems are present.

Many other insects infest and seriously damage wood. Many of these, such as the various bark beetles and round- and flatheaded borers, are found alive most frequently in seasoned wood. The pest management professional is usually most concerned with those insects that damage seasoned lumber.

These insects include representatives of the orders Hymenoptera (horntail or wood wasps, carpenter ants and bees) and Coleoptera (beetles). The members of these two orders develop by complete metamorophis, advancing from eggs to larvae, pupae, and adults.

The characteristics of the damage done to wood by these insects are generally sufficient evidence to identify the insects to their family, but positive identification to genus or species requires examination of the insect itself.

DARKLING BEETLE

Darkling beetles are generally **ground dwellers** that are active during the day and night. During the hottest part of the day, they burrow under sand to stay cool. Unlike most other beetles, darkling beetles cannot fly. Their wings are fused together and are useless.

Bark Beetles Sub-Section
The Tree Enemy


Cypress Bark Beetle


Ips Knausi


Ips Latidens


Pine engraver


Pinyon Ips


Six spined Ips


Six spined Ips


Southern pine beetle


Turpentine beetle


Turpentine beetle


Western pine beetle


Western pine beetle

There are many bark beetle genera, of which the most important with respect to forest damage are Dendroctanus, Ips, and Scolytus.

Adult bark beetles bore through the outer bark to the inner cambial layer, where they channel out galleries in which to lay eggs.

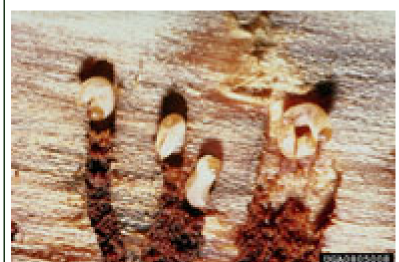

Red turpentine beetle (Galleries)


Red turpentine beetle (Damage - close)

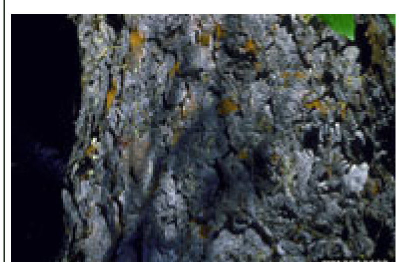

Spruce beetle (Adult)


Spruce beetle (Adult)


Spruce beetle (Eggs)


Spruce beetle (Larva)


Spruce beetle (Galleries)


Spruce beetle (Damage - close)


Spruce beetle (Damage - close)

Pictures Courtesy of the US Forest Service

Pine Bark Beetles

Pine bark beetles are generally of the genus ***Ips*** or ***Dendroctonus***. However, several other genera also attack pine, including: ***Hylastes, Hylurgops***, and ***Pityogenes***.

Often several species will attack at the same time. Identification of specific beetle species can be difficult. Identification can be aided by knowing the host species attacked, time of year, and the design of the galleries (tunnels) created by the adults and larvae.

Bark beetles contribute to the death of thousands of ponderosa pines in Arizona each year. Most often when larger trees are attacked and killed they have been weakened by drought, lightning, construction activity or they have been growing on poor sites. Of special concern is the loss of high-value trees at home sites or in developed recreation areas.

Evidence of infestation
Fading foliage in the tree is often the first sign of a beetle attack. Trees attacked by ***Ips*** spp. typically fade from the top of the crown downward, while ***Dendroctonus*** spp. killed trees fade from the bottom of the crown upward. The needles change from green to a light straw color within a few weeks to one year after attack and eventually become brown or red.

Dust caused by boring in the bark crevices and at the tree base is another sign.

Often, numerous small pitch tubes (globules of pitch 1/4 to 1" diameter) appear on the trunk of infested trees. The pitch tubes generally have a creamy appearance, much like crystallized honey.

A pink or red tint may be present in the pitch. The presence of one or two pitch tubes may not mean that a beetle was successful. Often a few pitch tubes can indicate that the tree successfully repelled the attacking beetle. Clear sap that runs down the bole (trunk) or limbs is generally not from bark beetles.

Life History
Life history varies with each species; the following description is true for most. Beetles become active in April and early May; adults emerge from trees, slash, or firewood infested the previous fall.

Adults prefer freshly cut green trees or trees stressed from drought but when a large number of beetles are present, they attack live pines. ***Ips*** spp. beetles characteristically attack the upper portion of the tree, but when beetles are abundant; the entire tree can be invaded and killed.

Several species will only attack the base of the bole.

Adults bore through the outer bark and then tunnel and lay eggs in the soft inner bark.

Eggs hatch in about a week and larva feed on the inner bark for six to eight weeks before they pupate. It is the boring activity of the adults and larvae that kill trees by girdling in combination with stain fungi the beetles introduce. The development of larvae and pupae of some beetles is completed in the outer bark.

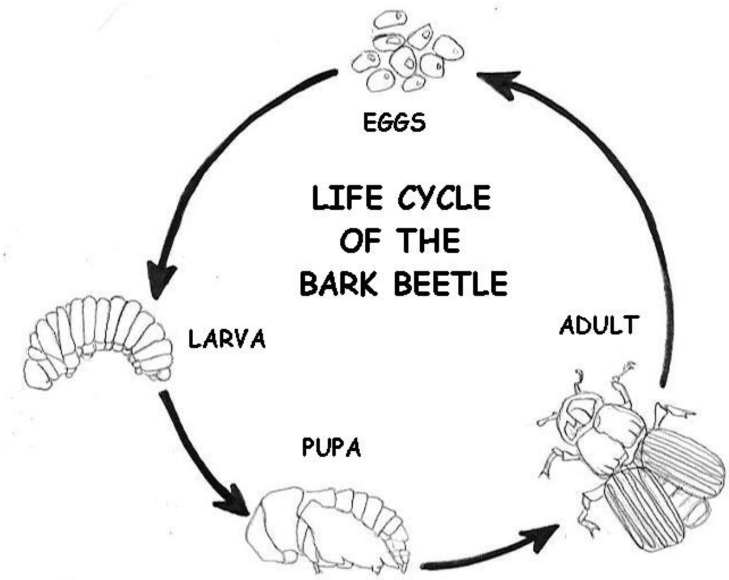
Adults develop from pupae and emerge by boring out through the bark. After emergence, adults fly and attack freshly cut material or susceptible trees and start the next generation. Most beetles produce one to two generations each year but some may have three or four. The overlap of generations during the summer may produce continuous attacks.

Prevention and Control
Freshly cut ponderosa pine slash and firewood are subject to attack by bark beetles.

You can see the evidence of the damage from Bark Beetles; the fire fuel is increased and needs immediate attention and removal.

The success of beetle attacks and production of young beetles are greatly influenced by which season the trees are cut in Trees cut during the late summer and fall are seldom successfully attacked, because the inner bark dries during the fall and winter. The inner bark of green trees cut from January to July remains moist and suitable for beetle habitat.

An exception to this is the roundheaded pine beetle, which flies during the fall, and attacks trees at that time.



Typical bark beetles are (4–6 mm) in length.

The best way to avoid having trees attacked by bark beetles is to take preventive measures. First and foremost, lower tree density through thinning. However, at this time of year thinning may cause increases in bark beetle populations due to the increased exposure of the remaining trees to May and June’s drying winds.

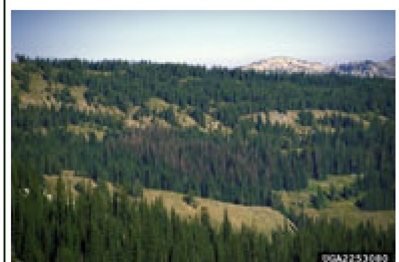
Furthermore, increases in beetle attacks may occur if the newly cut trees are left on the ground for more than 30 days. If the material is hauled off the property to a landfill where the material will be buried or if it is chipped it will not cause a problem. When chipping, don’t pile the chips deeper than 3 inches next to live trees, as the chips may attract bark beetles. If it is necessary to create piles deeper than 3 inches, keep the piles in the open sun and as far from live trees as possible. If removal or chipping is not an option, then it may be best to wait until October to begin thinning.

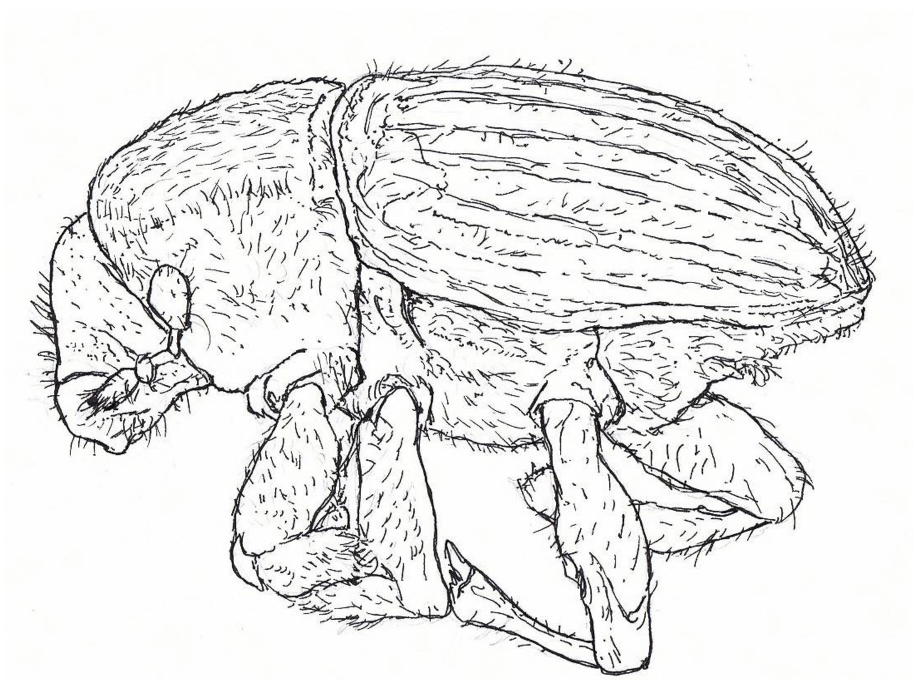
Roundheaded pine beetle activity was found near trees that had been thinned and chipped in October. The slash and limbs of green pine trees should be buried or burned (according to safe conditions and laws) within 30 days after a tree has been cut down. The bole of the tree should receive the same treatment, unless it is needed for firewood or poles. Then the material should be piled away from living pine trees and covered securely to the ground with heavy, clear plastic.

Bark beetles are a common presence on forested land in Arizona. Populations of bark beetle species increase and decrease from year to year. This is a common phenomenon for insect populations. During the summer of 2002, bark beetle populations increased and are creating a problem both for federal and state forested land and for private landowners.

The damage caused by bark beetles is exacerbated by the drought Arizona has suffered for many months. Trees stressed by drought are especially vulnerable to bark beetle attacks. The spruce-fir forests of the Pinaleño Mountains near Safford have suffered severe tree mortality from bark beetle and defoliating insect attacks for the past several years.

Bark beetle attacks have killed large numbers of trees in the spruce-fir forests of the San Francisco Peaks in Arizona. An estimated 100,000 pinion pines are dying in the transition zone east of Flagstaff. Ponderosa pines are suffering severe attacks in the Flagstaff area. Some neighborhoods in Flagstaff have lost nearly 100% of their pines.

 Spruce beetle (Damage - close)	 Spruce beetle (Damage - close)	 Spruce beetle (Damage - far)



BARK BEETLE (ADULT)

DOUGLAS FIR BEETLE (ADULT)

The currently recommended chemicals for this purpose are carbaryl and permethrin. You must use a product that is especially formulated for bark beetles, such as ***Sevin SL, Dragnet, Permethrin Plus C***, or ***Astro***. This is a protective measure only--it will not kill beetles once they enter the tree. Typical home and garden products containing carbaryl or permethrin will be ineffective. If correct materials are applied properly, protection can be effective for an entire season. Spraying should be completed prior to April 1 to ensure full protection.

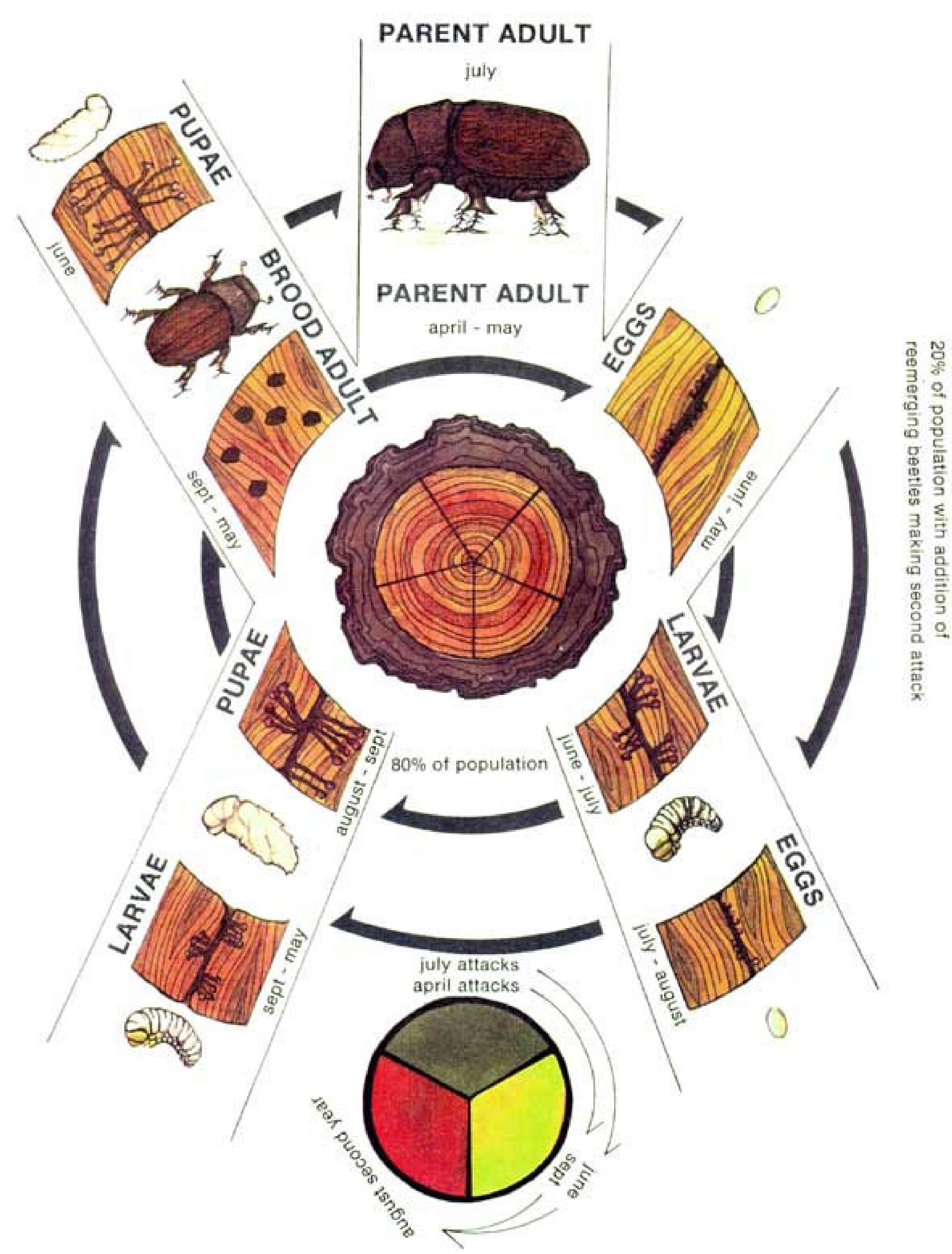
If spraying after April 1, you must be sure that the trees have not already been attacked. Trees can be checked for infestations by climbing, with a hydraulic lift, or with high-powered binoculars to inspect the entire trunk of the tree. Also, check the bark crevices and the base of the tree for fresh boring dust. Spraying trees already infested will prove to be ineffective.

The only known direct control method of infested trees is removal. A good rule to remember is "***If the tree is brown cut it down, if in doubt cut it out***." If we leave dead trees standing, we run the risk of the new generation of beetles leaving the tree and attacking more trees.

Finding reddish-brown boring dust in the bark crevices of a tree indicates that the tree has been successfully attacked, and the tree should be cut down even if the tree is still green at that point. If dead trees are next to houses or other structures, they can become a hazard.

Insecticide injections or systemics have not proven effective against ***Dentroctonus*** species of bark beetles in studies conducted by U.S. Forest Service and Canadian Forestry Service researchers. Many trees have been injected with what seemed to be success. What may have happened is that the treated tree successfully pitched out the attacking beetle with resin prior to the treatment. The tree was then injected with insecticide when in fact no beetles were actually in the tree. The tree saved itself!

Studies have shown that injecting chemicals will not kill ***Dentroctonus*** species of bark beetles attacking conifers, and actually injures the tree in the process. We are assuming that chemical injections will be equally ineffective on ***Ips*** species of bark beetles.

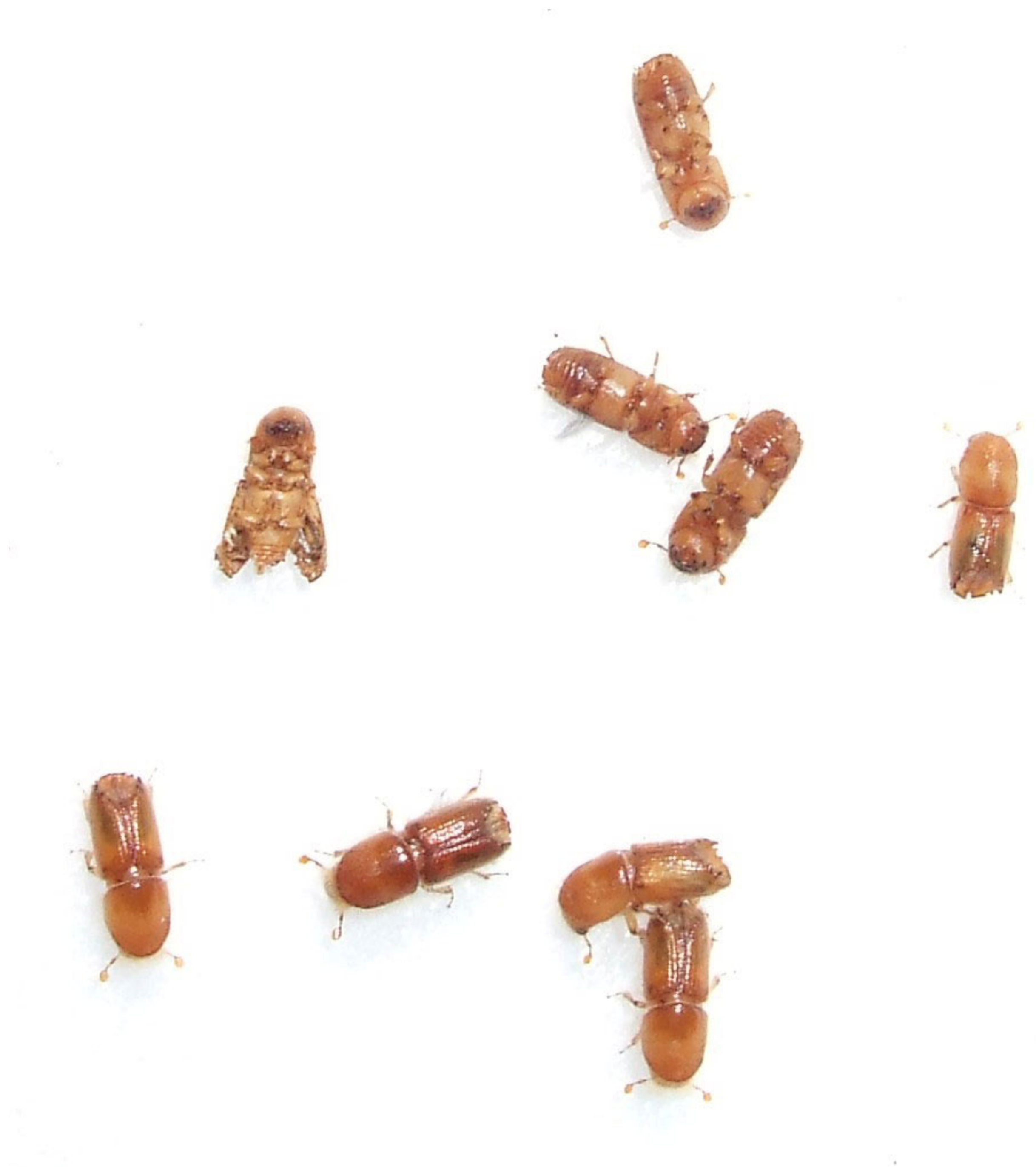


Color Cycle of Tree

Here an applicator is spraying a Pinion Pine for Bark Beetle and Pinion Scale control, these two insects will both attack and destroy a tree this size within 12-16 month period. This period will depend upon rain and weather conditions.

You have a less than a 40% chance of saving a tree as this one if the spraying is done within 3 months of infestation and spraying again on an annual basis (depends upon moisture and drought conditions). But, everything depends upon the weather. If it is dry, the tree has a greater chance of ending up in the fireplace. Bark beetles are also expected to kill most of Colorado's lodgepole pine trees.

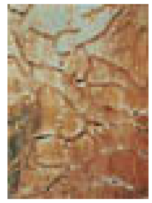
A pesticide applicator is examining bark beetle damage in a dead pine tree. The bark beetles had a protective layer of bark approximately 2 inches thick. It would have been nearly imposable to apply enough chemical to penetrate this hard bark exterior.



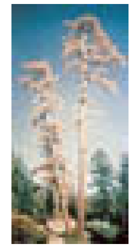
Bark Beetles have a hard protective head and are very strong. These insects almost bite you if you were to place them in your hand. They are like tiny bulldozers and will work hard to get out of your hand and into a fresh tree. I am truly impressed with their efforts.

Western Pine Beetle, *Dendroctonus brevicomis,*

Larvae.



Egg and larval galleries are usually packed with dust.



Killed ponderosa pine.

Tree Species Attacked: Mature to old ponderosa pine trees are attacked.

Insect Description & Damage Symptoms: One to two generations of beetles are produced every year, depending upon the elevation. Adults are brown to black, cylindrical, stout-bodied, hard-shelled, and about 3 to 5 mm long. They construct long, meandering, dust-packed galleries in the cambium of attacked trees. During periods of heavy attack, the galleries may cross and re-cross, forming a complex network.

The timing of western pine beetle attacks depends upon elevation, they can occur any time from May to September.

Reddish-brown boring dust will be present at the base of attacked trees. Inconspicuous reddish-brown pitch tubes can sometimes be found in bark crevices. Needles will pale and then fade to yellow, to reddish-brown, and finally to red in the months following the attack. Flaking of the bark by woodpeckers in search of beetles or larvae is also a symptom of infestation.

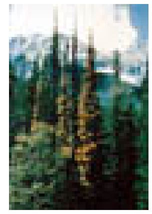
Damage: Usually, the western pine beetle breeds in scattered, old, slow-growing, or diseased trees; and trees weakened by stand stagnation, lightning, fire, or mechanical injury. This beetle, however, will also attack and kill healthy young trees during an epidemic, although trees under 15 cm in diameter are seldom attacked. Attacking adults also carry the spores of a blue stain fungus that can invade and block, along with feeding larvae, the conductive vessels of the inner bark and sapwood.

Similar Damage: May be confused with the mountain pine beetle or secondary beetles. The conspicuous serpentine galleries distinguish the western pine beetle.

Western balsam bark beetle, *Dryocoetes confusus*


Adult.


Larva.


Attacked trees. Note: this color usually appears within a year following an attack.


Egg and larval galleries.

Tree Species Attacked: Primarily sub-alpine fir is attacked, but occasionally, amabilis fir. Some attacks of white spruce and Engelmann spruce have been recorded. Mature trees are targeted.

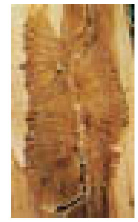
Insect Description & Damage Symptoms: Adults are 3.4 to 4.3 mm long, dark brown, and covered with erect, red-brown hairs. They emerge in late May or June. The life cycle normally requires two years, but given the right climatic conditions, it could be completed in one year. The extent of an infestation is difficult to determine as a result of overlapping life cycles, a lack of telltale pitch tubes, and the fact that the majority of the attacks occur above 2 m on the bole. The adults construct egg galleries that have a central nuptial chamber with brood galleries radiating from the top and bottom. A mixture of boring dust and frass is usually found in bark fissures and at the base of the bole. The foliage of an attacked tree will change from green to a bright, brick-red color in the year following the attack, but the red needles may be retained for up to five years.

Damage: Given the appropriate conditions, balsam bark beetles can be responsible for extensive tree mortality in stands containing a large percentage of the preferred host. Normally, however, less than 5% of a stand is attacked in a single season, with the damage usually scattered throughout the stand. The adult carries a lesion-causing fungus, ***Ceratocystis dryocoetidis****,* which is responsible for an estimated 65% of the mortality associated with balsam bark beetles. The lesions caused by the fungus may girdle and kill a tree, and they also make the tree susceptible to further beetle attacks.

Douglas-fir beetle, *Dendroctonus pseudotsugae*

Larva in gallery.

Adult Douglas-fir beetle.



Egg and larval galleries are about 30 cm in length and packed with frass.

Attacked trees. Note: red color usually appears by the spring of the year following an attack.

Boring dust can be found in crevices at the base of the tree.

Distribution: Throughout most of the range of its principal host. Damage is usually most intensive in the interior of forest.

Tree Species Attacked: Large-diameter, mature Douglas-fir trees are attacked, and occasionally, downed western larch.

Insect Description & Damage Symptoms: Adults are dark brown to black with reddish wing covers and about 4.4 to 7 mm long. The usual life cycle is one year, but two broods may be produced. The main flight period usually occurs in May and June, while a second flight in July and August may be made by adults developed from overwintering larvae or adults re-emerging after the earlier flight.

Adults lay their eggs in long galleries constructed parallel to the grain of inner bark. Reddish boring dust may be found in bark crevices or at the base of the tree. Adult beetles will often not attack the bottom portion of the bole, making identification difficult.

Pitch tubes are not formed, but the tree may exude resin from upper attacks. Foliage of killed trees turns from green to pale yellow-green to red by the spring of the year following the attack. Red needles may remain on the tree for up to two years after an attack and aerial spotting of these "***redtops***" helps to determine the extent of an outbreak. Sometimes needles will drop without any discoloration.

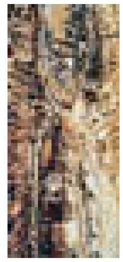
Damage: Douglas-fir beetles normally infest felled trees, mature damaged trees, logging debris, and trees stressed by drought. When sufficient host material is unavailable, however, they will attack and kill vigorous trees, causing more extensive damage. Trees are killed when the flow of food and water between the roots and needles is blocked by feeding larvae and by dead sapwood cells killed by the blue-stain fungi carried by the

Douglas-fir beetle adults. On the coast, it often takes two years of attack to kill a tree (partial or "***strip***" attack occurs the first year).

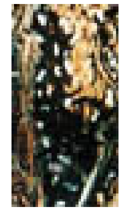
Similar Damage: Attacks by secondary bark beetles may produce boring dust in bark crevices. The Douglas-fir pole beetle is usually found in the smaller diameter, upper portion of the stem. It can be distinguished from the Douglas-fir beetle by its finer boring dust and different gallery patterns.

Ips beetle, ***Ips spp.,***

Adult. Note: rear concave depression lined with spines



Egg and larval galleries. Larval galleries radiate from the central nuptial chamber. No frass is present.



Larvae brood in a lodgepole pine tree. Ips galleries tend to contain multiple generations.

Tree Species Attacked: The most critical attacks occur in pole-size to mature lodgepole pine, ponderosa pine, and western white pine.

Insect Description & Damage Symptoms: Adults are reddish-brown to black, often shiny, cylindrical, and about 3 to 6 mm long. An easily recognizable feature of the adult is a pronounced concave depression at its rear end, which is lined on each side with up to six tooth-like spines. The head is not visible when viewed from above.

Adults emerge and begin their attack from mid-May to early June. Pitch tubes are rarely formed or are very small, but fine yellow-red boring dust is usually found in bark crevices.

Attack usually advances from the top downward on standing trees. A change in the foliage color from dark to faded green is usually the first obvious symptom, but the best way to determine if a tree has been attacked by Ips is to remove a piece of bark and examine the tree for evidence of egg galleries. Ips egg gallery patterns consist of a central nuptial chamber from which two or more egg galleries radiate.

Larval galleries extend at right angles to the egg galleries and often score the surface of the sapwood, a characteristic that causes some to call the Ips "***engraver beetles***".

The galleries are free of boring dust and frass. As the tree or top portion of the tree dies, color change continues to yellowish-red and then a dull brick red. Two to three generations of beetles may be produced per year; therefore, engraver beetle populations can expand rapidly

Damage: Ips beetles usually only attack dead, dying, or damaged trees. They are also often found in the upper portions and on the south sides of trees attacked by the mountain pine beetle, and in conjunction with black-stain fungus. However, heavy populations can build up in windthrow and slash, which can pose a threat to healthy green trees. Ips damage often occurs at the edges of cut blocks.

Similar Damage: May be confused with mountain pine beetle or other secondary beetles. Ips beetles can be distinguished by the gallery patterns and the distinct shape of the adult.

Fir Engraver Beetle, *Scolytus ventralis*

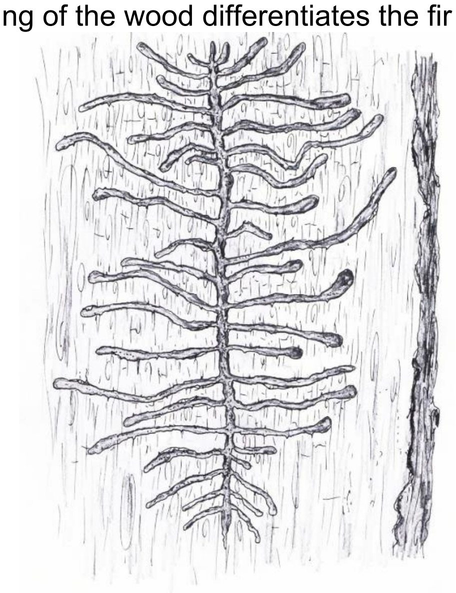
Tree Species Attacked: The primary hosts are true firs, though occasionally Douglas-fir and spruce are infected. Trees from pole-size to mature are susceptible.

Insect Description & Damage Symptoms: The adult beetles are shiny, black to reddish-brown, and about 4 mm long. A side view shows that the end of an adult's abdomen is incurved.

The beetles bore into the inner bark of trees from June through September, leaving reddish-brown boring dust on the outer bark. The beetles introduce a brown-stain fungus to the sapwood. The galleries the beetles form are very distinctive, in that the egg gallery is constructed horizontally across the grain of the wood for a distance of 5 to 15 cm on both sides of a central entrance chamber. These galleries are deeply scored into the wood. When they hatch, the larvae mine up and down the bole for distances of 13 to 18 cm. The life cycle of the fir engraver beetle is usually completed in one year, though in colder, upper elevations it may take up to two years to complete.

Damage: Trees are often top-killed, can be killed outright if attacked by enough beetles, or may survive repeated attacks for many years. Trees that survive may only be attacked in patches on the bole. Within a patch attack, the cambium is killed and a brown pitch pocket is formed in the wood. These partial attacks are seen externally as roughened patches of bark or scattered dead branches that have been girdled by egg galleries. Trees that are weakened by drought or root disease are particularly susceptible to attack. Populations can build up in slash or windthrow before attacks are made on living trees.

Similar Damage: May be confused with other bark beetles initially, but the distinct gallery pattern and the deep scoring of the wood differentiates the fir engraver beetle.



BARK BEETLE TRAILS (DAMAGE)

Related Tree Borers

Leaf-feeding Caterpillars
All species of poplars are affected by some sort of leaf-feeding caterpillar. Larva feed on the buds or the leaves causing a lacy appearance. Infestations usually aren't fatal, but several successive years of attack can weaken a tree enough to kill it. Insecticides can be effective to treat infestations.

Leaf Beetles
Leaf beetles from the species *Chrysomela* can cause substantial damage to poplars in urban settings. After spending the winter in the bark or other shelter, the adult beetles emerge in the spring and feed on the leaves and twigs.

Females lay yellow eggs on the underside of the leaves and the larva then also feed on the leaf tissue between the veins. Insecticides can be effective, but because four or more generations of the beetles occur each year, multiple applications in a single year may be necessary.

Cottony Cushion Scales and Mealybugs
White, cottony masses covering leaves, stems and trunk is an indication of cottony cushion scales or mealybugs. The two insects are very similar and they are quite common. Pale yellow or reddish larva feed throughout the summer on leaves stem and trunk. They excrete honeydew which often becomes black. When white egg masses completely cover leaves and twigs, dieback can occur. Insecticides can be used to kill the larva, while a dormant spray can be used to kill overwintering adults.

Scales
Poplars can be infested with many types of scale insects which settle on the leaves, twigs, and trunk. Small and soft-bodied, the young feed by sucking sap from the tree.

Their legs atrophy and a hard crusty shell develops around their bodies. To control them, use insecticide for the active young and a dormant spray for the overwintering adults.

Poplar-and-Willow Borer
This weevil (*Cryptorhynchus lapathi*) affects many species of poplar as well as all species of willow. Although the adults cause some damage by chewing holes in bark and twigs, the major damage is caused by the white larva which burrow into and feed on the inner bark.

Large quantities of sawdust known as frass are expelled from the holes. This activity disrupts the water-conducting system of the tree and weakens branches. Infected trees should be removed to prevent further spread.

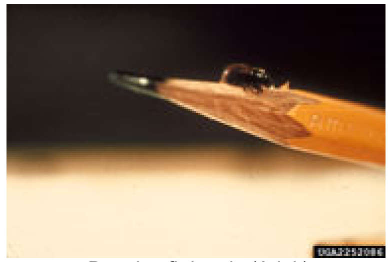
Poplar Petiolegall Aphid
Galls forming on the leaves of poplars are caused by the Poplar Petiolegall Aphid (*Pemphigus populitransversus*). Although the galls are unattractive, they do not cause serious damage to the tree. In summer, the galls produce winged aphids which fly to vegetables such as lettuce and beets to feed on the roots. In the fall, they return to the poplar to lay eggs. In winter, a dormant spray can be effective in controlling these aphids.

The pinyon needle scale can be controlled on selected trees by spraying a dimethoate-water emulsion (3 gals. of a 30.5 percent emulsifiable concentrate per 100 gallons water, approximately 1 percent) to egg masses at the base of the trees and to all bark and crotches that can be reached from the ground. Make this bark application when crawlers, start to emerge from the eggs.

Crawlers emerge about 7 to 10 days after red eye spots become visible in the eggs under a hand lens, normally in early June in northern Arizona - New Mexico and southwestern Colorado. Timing the spray application is critical for effective control. Use hydraulic or back-pack sprayer. Do not spray needles since phytotoxicity may result: Do not apply to pine trees used for pine nut or pinyon nut production.

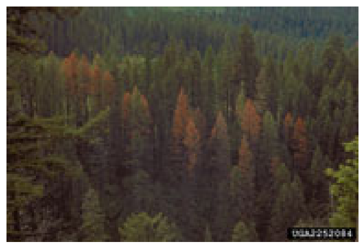
Preventative Spraying for Ips and Western Pine Beetles

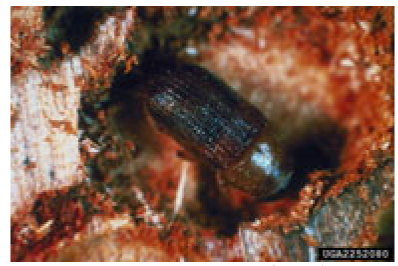

Douglas-fir beetle (Adult)


Douglas-fir beetle (Adult)


Douglas-fir beetle (Galleries)


Douglas-fir beetle
(Damage - close)


Douglas-fir beetle (Damage - far)

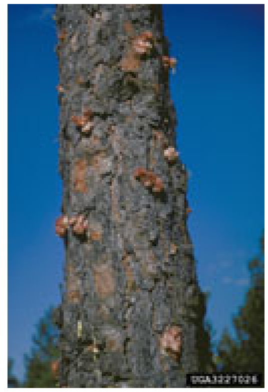

Mountain pine beetle (Adult)


Mountain pine beetle (Adult)


Mountain pine beetle (Larva)


Mountain pine beetle (Pupa)

The western pine beetle WPB and ips species are insects capable of attacking and killing ponderosa pine and pinion pine. Periodic epidemics are capable of causing heavy mortality in drought stressed and dense stands of pine. Many situations exist where high-value pines require protection from uncontrolled beetle pressures nearby.

 Mountain pine beetle (Galleries)	 Mountain pine beetle (Damage - close)	 Mountain pine beetle (Damage - close)
 Mountain pine beetle (Damage - far)	 Mountain pine beetle (Damage - far)	 Pine engraver (Adult)
 Pine engraver (Galleries)	 Pine engraver (Damage - far)	 Red turpentine beetle (Adult
Pictures Courtesy of the US Forest Service		

Pinyon Needle Scale

Pinyon needle scales, known by their scientific name, (*Matsucoccus acalyptus*), are .5mm in size. Wingless females emerge from scale coverings on the bark of the tree in April to mate with male insects that have wintered in webs beneath the trees.
After mating, the female lays visible eggs. Four to five-and-a-half weeks later, the nymphs hatch and crawl to the tree's upper foliage to feed. Once they start to eat, they cover their bodies with a waxy coating that safeguards them against the environment, predators and contact insecticides.

The pinyon needle scale defoliates juvenile pinyon pine (*Pinus edulis*), while the stem-boring moth (*Dioryctria albovittella*) kills shoots of mature trees. The impact of these herbivores is regionally extensive, encompassing pinyon woodlands on a variety of substrates, and appears to be positively correlated with abiotic stress.

Studies demonstrate that scale and moth herbivory chronically reduce stem growth and reproduction, alter tree architecture and soil microclimate, decrease mycorrhizal mutualists, and increase litter quality. In all major functional groups of organisms examined to date (i.e., soil bacteria and fungi, litter and canopy arthropods, and birds and mammals), we have found fundamental differences in abundance and/or composition between high- and low-herbivory trees and sites. Thus, it is clear that tree performance, community structure and biodiversity are dramatically altered by chronic herbivory in this ecosystem. We do not know, however, to what extent basic ecosystem functions are also affected.

Taking advantage of two long-term moth and scale removal experiments, (15 and 13 years, respectively), we propose to examine the ecosystem effects of herbivory in experimental plots centered on three classes of trees, **1)** Trees infested with moth or scale insects, **2)** Susceptible trees from which these herbivores have been removed annually for at least 13 years ("defaunated" trees), and **3)** moth or scale resistant trees. We emphasize that our uniquely long-term defaunation treatments allow us to compare *experimentally*

the ecosystem consequences of chronic invertebrate herbivory, consequences that may require long periods to develop.
We propose four hypotheses concerning ecosystem responses to chronic herbivory:
1) Herbivory reduces net primary productivity (NPP) overall, but particularly belowground, such that the ratio of aboveground-belowground NPP increases.
2) Reduced soil C inputs due to herbivory increase microbial C limitation, reduce N immobilization and enhance net N mineralization.
3) Herbivory increases litter nutrient quality by preventing retranslocation prior to litterfall, which will increase nutrient loss via leaching due to reduced belowground NPP.
4) By significantly altering tree architecture, the two herbivores will have significant but opposite indirect impacts on litter decomposition and nutrient cycling by changing soil temperature and water regimes.

Testing of these hypotheses and related predictions is crucial to understanding the roles of major herbivores on populations, communities, and ecosystems.

"Removal of the eggs from your pinyons will be simplified if you have already treated your vegetation for fire prevention (by thinning and pruning)," Celaya said. "If you have pinyons infected with needle scale, you can basically walk right up to the tree and see the egg masses. Of course, if you haven't pruned, it will be hard to get to the egg masses on those trees."

Ways to Detect Scale-infested Pinyons
• Clusters of yellow eggs held together in loose, white, cottony webbing in branch crotches, the underside of large branches and the base of the trunk.
• Yellow-orange discoloration of needles toward the back of the branch.
• Needles covered with small, black, bean-shaped scales.

Control of the scale at this egg stage of the insect is a three-part process. First, wash the eggs off branches and trunk with a garden hose, equipped with a high-pressure nozzle, then allow the eggs on the ground one or two days to dry.

Next, rake the eggs out from under the tree. Then, dispose of the eggs in plastic garbage bags.

Proven Methods (Prevention)

Preventive spraying provides a proven method of keeping un-infested but susceptible pines alive, despite attempted attack. As such, it is relatively safe and affordable "***insurance***" that protects key trees until the nearby beetle threat subsides.

CANDIDATE TREES – **In the great majority of cases, trees selected are big, valuable ponderosa and pinion pines.** Of course, trees selected should be species normally attacked by either the western pine beetle or ips beetle. If these are the insects of concern, then spruce, fir, and juniper do not need to be treated. (Note, these species are attacked by other bark beetles and may warrant preventive spraying when their respective threats are present.)

Preventive spraying involves the application of pesticides and is usually performed by commercial applicators. Because of the associated environmental considerations and expense, it is neither practical nor advisable to spray every tree on a tract of land. Rather, preventive spraying is intended for important, "***must-save***" high value trees.

Since WPB and ips rarely attack trees under 4 inches in diameter, smaller trees do not normally require spraying. These beetles attack stressed trees more often than healthy ones. Stress factors include: mistletoe, root cutting, bark wounding, soil compaction, drainage changes, adverse weather (such as drought), and infestation by other insects. A tree's value is subjective, but typically comes from its size, pleasing shape, shade and proximity to recreation sites and homes.

Home builders should remember that trees carefully saved during construction were probably stressed, and as such, are attractive to beetles. Other highly vulnerable trees are those with infested firewood stacked against them and those near infested trees from which the WPB and Ips will fly.

WHEN TO SPRAY – Based on the tested residual of materials registered for preventive bark beetle spraying, treatment needs to be done before beetle flight in **March or April on an annual basis during years when the risk of beetles is high.**

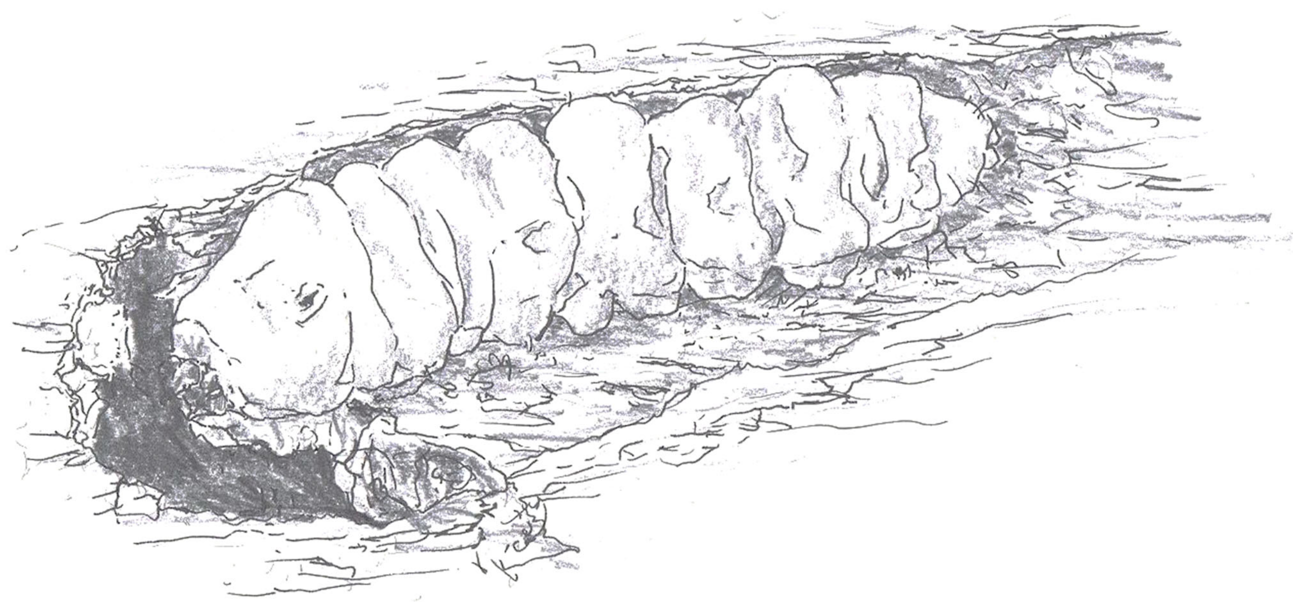
Infestations can last a number of years in a local area and are often dependent on host availability and weather conditions. High precipitation years will help the pine produce sap needed to fend off beetle attacks.

CHEMICALS LABELED FOR PREVENTIVE SPRAYING - Over the past 20 years, the standard for bark beetle preventive spraying has been **carbaryl (trade name Sevin)** This carbamate has long been used for the control of leaf-chewing insects in both forest and garden situations. Carbaryl comes in many formulations.

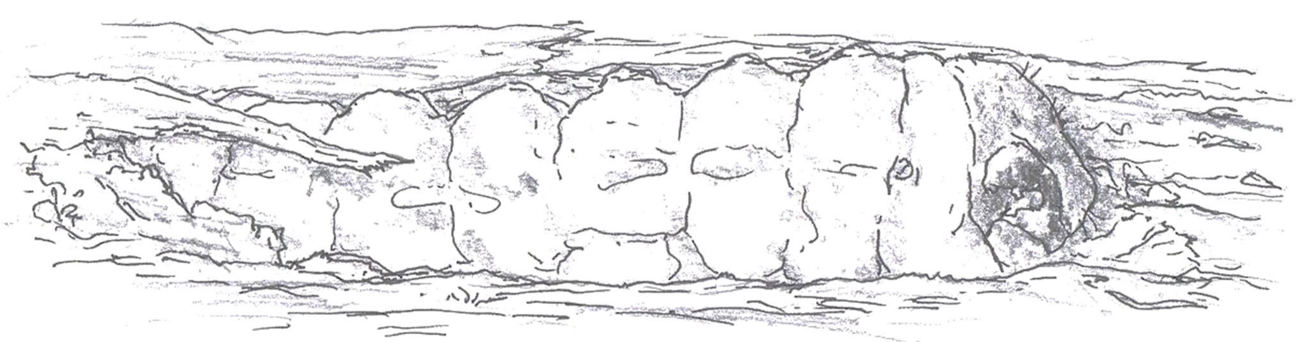
The liquid concentrates designed for use on large trees require dilution with water prior to application. Never dilute with petroleum liquids such as diesel fuel. Carbaryl is most effective when the pH of water used for dilution is 6 (slightly more acidic than neutral). When using water of pH 7 to 8, it may be advisable to add household vinegar to the spray mixture to achieve a pH of 6. (A pint of vinegar is enough to lower the pH of 25 gallons of spray about 1 point).

ALWAYS READ THE LABEL FOR COMPLETE MIXING INSTRUCTIONS AND SAFETY PRECAUTIONS.

Since about 1995, a second material called **permethrin (trade names Astro, Dragnet and others)** has been used for bark beetle prevention. This synthetic permethrin performed very well as a preventive bark beetle spray in research tests in California, Montana, and the South.



POPLAR BORER LARVAE AND DAMAGE EXAMPLE



LOCUST BORER LARVAE AND DAMAGE EXAMPLE

Techniques for Bark Beetle Control

- **Salvage.** This technique is usually feasible only when a relatively large volume of wood is available. Prompt action in salvaging large infestations is often necessary to prevent beetle expansion and to realize the best possible return from the sale of infested trees. Any trees containing beetle broods in salvage operations should be removed from the site before beetles emerge. Lack of small timber harvesting operators and the depressed pulpwood market make salvage removal difficult if not impossible.

- **Cut and Leave.** Attacked trees and a border of healthy trees are felled toward the center of the spot. High temperatures on the top of the trees, increased humidity on the bottom and increased predation from other forest insects and animals may combine with disruption of emergence and attack patterns to make this an alternative for beetle control. However, results of recent research are ambiguous as to the effect of this technique.
- **Pile and Burn**. This may be a viable option for small infestations in rural areas when weather conditions permit. The trees are felled in the same manner as for the cut and leave or salvage techniques. Heavy equipment is often necessary to pile trees together so they can be burned. Remember, if you burn, you must first get a permit.
- **Chemical Application.** Chemicals will protect healthy trees and/or kill broods of beetles within infested trees if they are used properly. Chemical application is most often impractical in a forest but may be an alternative for homeowners who want to protect high value trees.

There are currently three insecticides registered for control of bark beetles on southern pines. These include lindane, chlorpyrifos (***Dursban 4E***) and fenitrothion (***Sumithion 8E***). Landowners may purchase lindane for their own use without an applicator's license. The other two insecticides are available to professional pest control operators.

Lindane will protect pines for up to 12 months from SPB and Ips beetles. Information on Dursban and Sumithion is not yet available to show this level of protection.

Prevention is Best Control Method:
The best treatment for bark beetles is prevention. Even though they cannot always be prevented, good silvicultural management greatly reduces the risk of attack.

Combinations of the following practices can be used to improve forest health.
- Thin overstock stands. The degree of thinning will vary according to management objectives and product options. Basal areas of 80 to 100 square feet per acre are recommended in order to maintain a vigorously growing stand.
- Harvest mature and over mature stands. Trees that have matured and are growing slowly are more likely to be attacked. Regenerate with more resistant species.

- Protect trees during harvest operations. Minimize logging damage to trees. Salvage trees that have mechanical injury or are damaged by lightning, wind or ice since they are more subject to attack by beetles.

Good forest management is the key to preventing and controlling pine beetles. Call your local Forestry Commission or Extension office for more information.

MAGNIFIED VIEW OF A TERMITE

Application Guidelines

Application of preventive sprays can be a do-it-yourself activity, but is usually done by commercial contractors, who must meet rigorous training, experience, licensing, and insurance requirements. If contractors are used, it is proper to ask for credentials.

Preventive spray is applied to the trunk from the ground up to a height where the trunk narrows to 4 inches. Large branches need to be treated out to a 4" diameter also. Spraying should wet the bark, but only to the point of run-off. Material needs to get into bark crevices. The entire circumference must be treated. Pine foliage and branches less than 4" in diameter do not need to be sprayed.

Spraying should be done with an eye on the weather. Avoid excessively windy or freezing days. **At least two (2) hours of rain-free weather should follow the application to allow proper drying.**

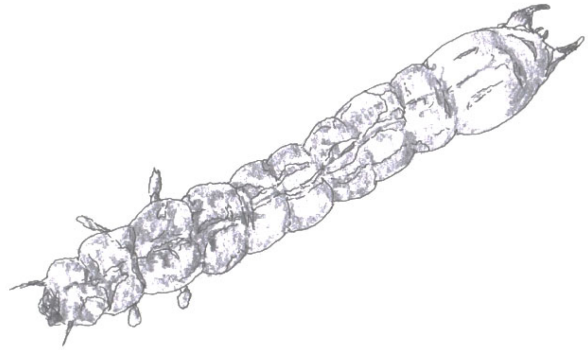
Use formulations that are labeled for bark beetle prevention and specifically designed for use on trees.

Usually these contain additives called "***stickers***" which allow better adherence to bark.

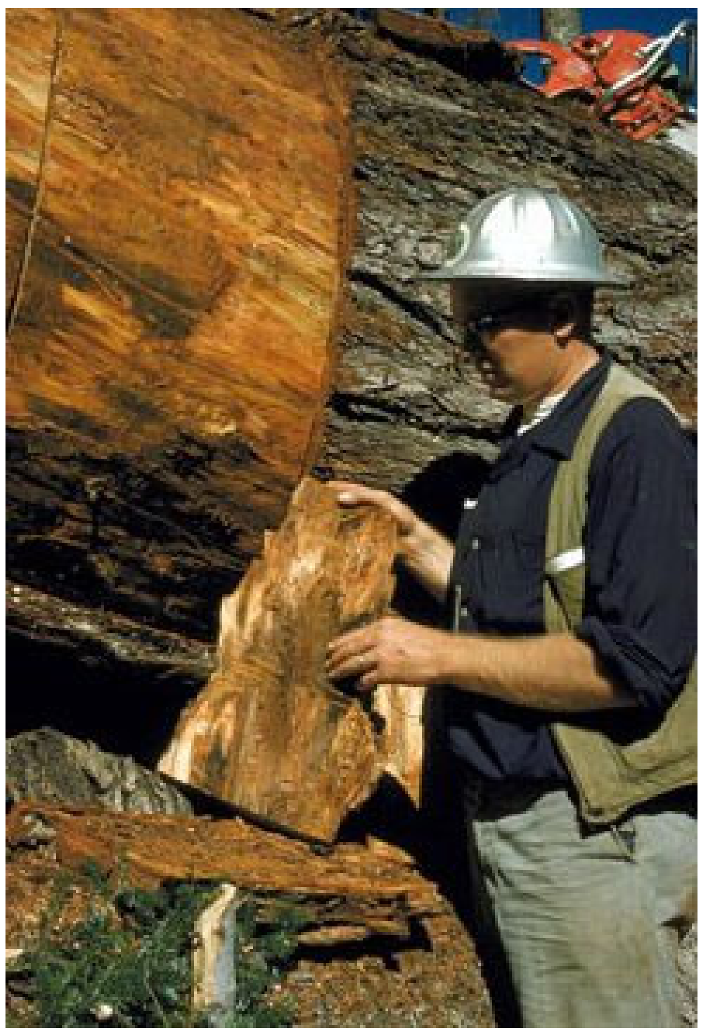
It is a good idea to identify or "***mark***" trees which have been sprayed. Placing a spot of spray paint at the base of treated trees is one method.

FOLLOW ALL SAFETY GUIDELINES ON THE LABEL. While these materials are safe when used properly, practice common sense with regard to the presence of wildlife, livestock, pets, and children during the application and drying period.

Most preventive spraying failures are due to:
1) improper treatment height
2) entire circumference not treated
3) applied too early or too late
4) wrong material
5) right material mixed improperly



BARK BEETLE LARVAE



What can private landowners do to protect their trees against bark beetle attacks?

Here is a short list of preventative measures.

1. Reduce the density of trees in your yard or woodlot by thinning. Most landowners are reluctant to cut down any of their trees. Keep in mind that trees will grow faster and stronger if they have less competition from neighboring trees. Trees that do not have to compete for scarce water will be more likely to survive both severe drought and bark beetle attacks. For the health of your trees, and to curtail the spread of bark beetles, keep the density down. The Bark Beetle News Release below explains how to determine the proper spacing for your trees.

2. In times of drought or insufficient rain, water your trees. This is particularly necessary during May, June, and October. During a severe drought period such as we have recently experienced, it may be advisable to water at other times as well. Enough water must be provided to penetrate the soil to a depth of two feet. Water in a donut-shaped pattern at the drip-line, or outer edge of the branches. To find out if your tree needs to be watered, check the soil to a depth of 6-8 inches just outside the drip-line at least once a month.

3. A landowner may have certain highly valued trees, treasured because of size, location, appearance, or other reasons. Valued trees that have not yet fallen victim to bark beetles can be protected from beetle attacks by the application of insecticide to the outside of the trunk. The only registered chemicals for use against bark beetles are carbaryl and permethrin. An insecticide specifically formulated for bark beetles is applied to the entire trunk and the base of branches 4" or greater in diameter. Common home and garden insecticides, even those containing carbaryl or permethrin, will not work. See the Bark Beetle News Release for more information, or contact your county Cooperative Extension office. Instructions for insecticide spraying are given below in the document Preventative Spraying.

Recognizing bark beetle attacks.

Most species of bark beetle are very small, and not commonly seen unless bark is removed from an infested tree. They are not found flying around or crawling on branches or the outside of the trunk. Fading foliage (changing from green to yellowish-green to sorrel to red and finally to rusty brown) is frequently the first sign the landowner notices. By the time the needles have faded to red, the bark beetle attack has been under way for a considerable time, and the tree is dying. Other signs are many pitch tubes (globules of pitch ¾ to 1¼ " in diameter) on the trunk, and boring dust in bark crevices or at the base of the tree, produced when the beetles bore into the bark. See the Pine Bark Beetles Publication for additional information.

What can be done for trees already attacked by bark beetles?

The unfortunate answer to this question is that nothing can be done, except to remove the tree.

Injection of insecticides or systemics has been shown to be completely ineffective in killing bark beetles or larvae already in the tree. Sometimes a tree will have a fading crown but the lower branches will still be green. Topping the tree, or removing the crown, will not save that tree.

The tree has already been weakened from the attack to its upper trunk. If bark beetles are not yet in the lower part of the tree, it will soon be attacked by beetle species that target the lower trunk.

Prevent the spread of bark beetles from this tree to others by removing it expeditiously. Many trees may only have the top half of the tree dead. In 2002 we saw the lower half of the tree was killed shortly thereafter.

Do not cut the top out of the tree hoping that the rest of the tree will recover. It is best to remove such trees to prevent the spread of beetles to other trees and to prevent them from becoming a hazard.
You need not wait until the entire tree turns brown--many adult beetles may have flown from the tree before it turns brown. Dead trees that do not have bark beetles in them and do not pose a safety hazard can be left in the forest to be used by wildlife.

Remember, the most effective method for preventing bark beetle infestations is to thin overly dense stands of trees in the right way, at the right time of year, using the right equipment with proper training. If you need more information please contact your local Cooperative Extension office, State Land Department, or your local fire department.

Application of fertilizers will not help protect trees from the effects of drought, and will not protect against bark beetle attacks. Fertilizers may even hinder the ability of the trees to fight off bark beetles. Fertilizers often cause trees to put on extra growth, this growth will require higher levels of moisture to maintain healthy conditions. Fertilizers may also burn foliage if improperly applied.

Un-infested trees can be protected from beetle attacks by spraying with insecticides. When spraying, the entire trunk and the base of large branches 4” in diameter and greater must be soaked. Spraying large trees is generally not a practice that homeowners can do themselves.

The small slash (limbs and tops less than 3 inches in diameter) can be used by adult beetles but they won’t reproduce in it. This material should be chipped if possible.

When piling, put the smallest diameter material in the middle with the largest on the outside.

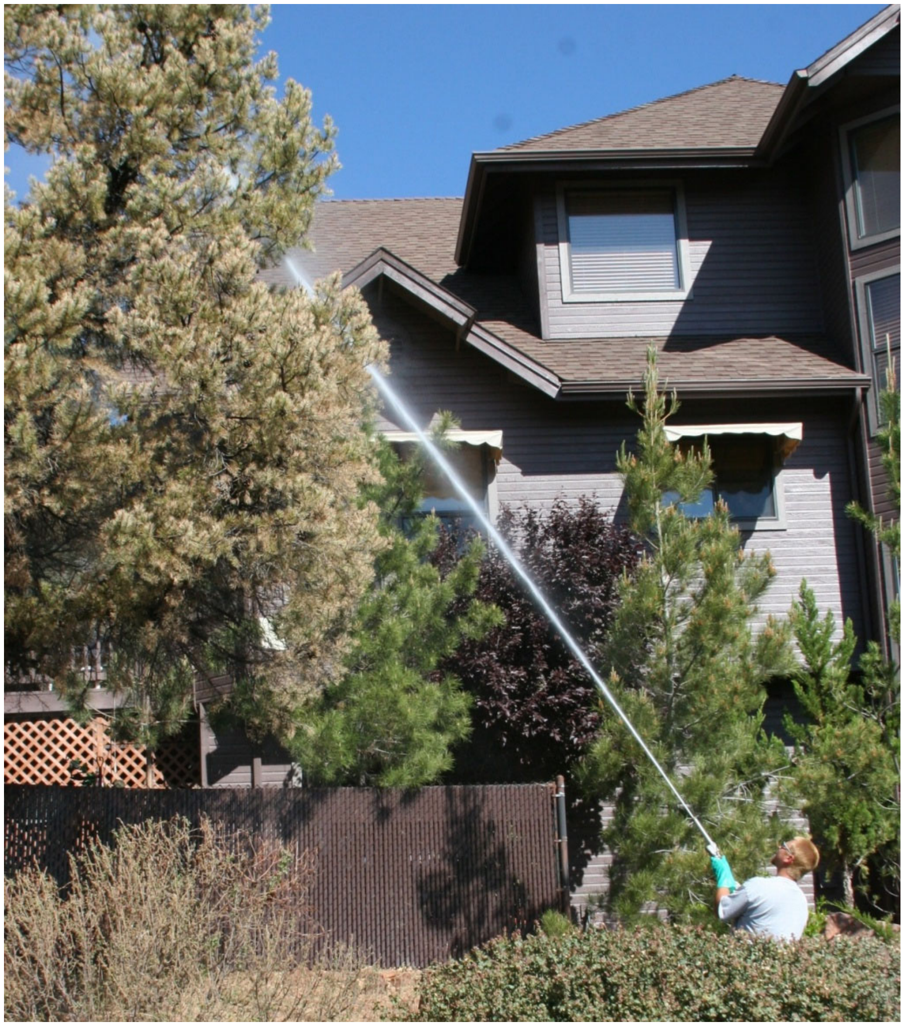
Often property owners will have several trees that have significant value in their landscape. These trees may be valued for their size or location. These high value trees can be given additional care to prevent infestation. They can be irrigated or sprayed with preventative insecticides.

When irrigating native pine trees they should be given enough water to wet the soil at least two feet deep. The water should be applied in a donut shaped pattern at the dripline, or outer edge, of the branches.

It generally takes about 2” of rain to soak 2 feet deep. Check the soil 6 to 8 inches deep just outside the dripline of the trees monthly.

If the soil is dry, then water. Generally, the months that most often warrant watering are May, June, and October.

However, depending on weather patterns watering may be needed any month of the year. If current dry conditions continue this spring you may need to irrigate at the end of April. Keep in mind watering restrictions that may be in effect in your community and follow those guidelines as well.



The currently recommended chemicals for the control of Bark Beetles are carbaryl and permethrin. You must use a product that is especially formulated for bark beetles, such as Sevin SL, Dragnet, Permethrin Plus C, or Astro. This is a protective measure only; it will not kill beetles once they enter the tree. Typical home and garden products containing carbaryl or permethrin will be ineffective.

If the correct materials are applied properly it can be effective for an entire season. Spraying should be completed prior to April 1 to ensure a full season of protection.

If spraying after April 1, you must be sure that the trees have not already been attacked. Trees can be checked for infestations by climbing with a hydraulic lift, or use high-powered binoculars to inspect the entire trunk of the tree. Also check the bark crevices and the base of the tree for fresh boring dust. Spraying trees already infested will prove to be ineffective.

Fumigants (sulfuryl fluoride) treat all infestations simultaneously and have high levels of efficacy if correctly applied. Sulfuryl fluoride kills drywood termites in about 3 days. A monitored fumigation, which involves installing gas monitoring lines inside the structure undergoing treatment, has the highest rate of treatment success.

Non-monitored fumigation may not have enough gas concentration to kill infestations, and failures may occur.

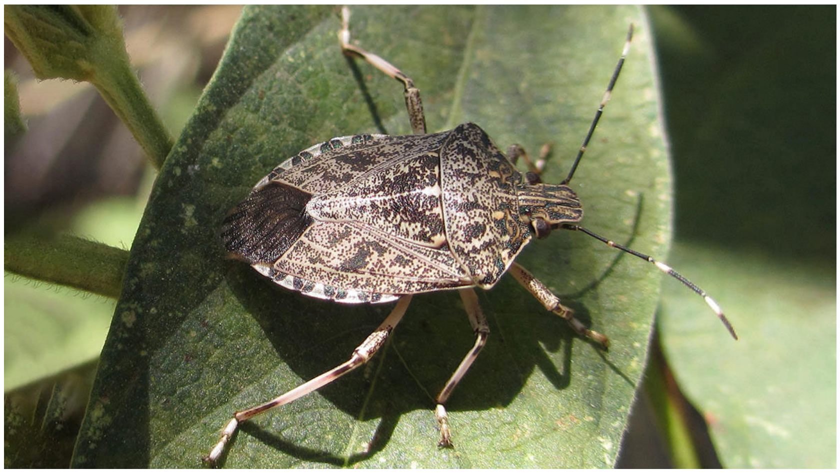
Fumigation's advantage over localized treatment is that it may eliminate infestations that are hidden from view. Major issues to consider with the use of fumigants include the difficulty of installing tarpaulins, the difficulty in determining the proper dosage, the need to protectively bag food items, and the lack of residual control.

Residual control means long-term protection (several years or more) from drywood termite attack. (Generally, only chemicals added to or onto wood provide residual control.) It will also be necessary to vacate the structure for 2 to 3 days while it is being treated and then ventilated. Additionally, roofs may be damaged by having tarpaulins dragged across them.

Methyl bromide was another fumigant used for many decades in California to control drywood termites. However, because of environmental concerns about the atmospheric ozone layer, the strong odors of some formulations, the long aeration times for fumigated structures, and the need for extensive aeration buffer areas around structures, this fumigant has been phased out for urban use in California.

Insects that look like Wood Destroyers

These insects look just like wood destroyers and are often found inside homes. Many of these insects are in the same insect family orders. Many of these insects have 10,000 to 20,000 variations and species. Some of these insects are very difficult to properly determine, however, you can generally figure their proper family and therefore the proper treatment. All of these insects are considered human pests.



Bark Stink Bugs – Plant Pest Only
Smaller and less elongated than adult kissing bugs. Mouthparts slender and held next to the body. Spines along front margin of the shield behind the head. It does not bite and is rarely seen indoors.

Bed Bugs – Human Blood Feeder, looks like Ips Beetle/Carpet Beetles
Bedbugs are small, oval, brownish insects that live on the blood of animals or humans. Adult bedbugs have flat bodies about the size of an apple seed. After feeding, however, their bodies swell and are a reddish color.

Box Elder Bugs - Plant Seed Pest Only
Smaller than most kissing bugs, red eyes and markings on the wing. Lacks bands around margin of the abdomen. Feeds on the seeds of maples and box elder trees. Common in the fall, often entering homes for warmth. Does not bite.

Leaf-footed Bugs – Plant Pest Only
As large, or larger, than kissing bugs. Hind legs swollen or flattened, sometimes into leaf-like shapes. These insects feed on plant seeds. They do not bite and rarely come indoors.

Squash Bugs – Plant Pest Only
Approximately the same size as kissing bug, but note the short, triangular head–it lacks the cylindrical shape and long “neck” of kissing bugs. Mouthparts thin and held close to body. This insect is a plant feeder and common pest of zucchini and other squashes. It does not bite and rarely comes indoors.

Wheel Bugs – Toxic Human Pest and Plant Pest
Meet yet another type of assassin bug. Wheel bugs are easy to spot thanks to the ridged wheels protruding from their backs. Their bite is one of the most painful you can receive from an insect due to an intense toxin, so we wouldn’t suggest handling them.

Spider Beetles

While they're a bit smaller than bed bugs, it's easy to see why people regularly misidentify spider beetles—especially if you're not particularly familiar with either insect. It is probably the fact that most spider beetles are reddish-brown in color (although some are black) that causes the confusion. That, and the shape of their bodies, which are shiny and oval shaped. Like bed bugs, spider beetles prefer dark, secluded places to hide—pantries, warehouses, and especially attics if they contain rodent, bird or bat droppings.

SPIDER BEETLE

It is a misconception that spider beetles depend, like bed bugs, on the blood of human hosts. In fact, spider beetles rarely bite humans. For the most part they live on the foodstuffs found in most pantries. If you find holes in food packages, silken coons, or webbing in any exposed food, these are sure signs that you have a spider beetle infestation.

Spider beetles make up the subfamily **Ptininae**, in the family Ptinidae. There are approximately 70 genera and 600 species in the subfamily, with about 12 genera and 70 species in North America north of Mexico.

Spider beetles have round bodies with long, slender legs. Many species are flightless, either in females only or both sexes. They are generally 1–5 mm long, and reproduce at the rate of two to three generations per year. They are so named because of a resemblance to spiders. Some species have long legs, antennae that can seem like an additional pair of legs, and a body shape that may appear superficially like that of a spider.

The larvae and the adults of most spider beetles are scavengers on dry plant or animal matter, but some species are known to be ant associates.

Swallow Bug -*Oeciacus vicarius* Horvath – Not Bed Bugs, Not IPS Beetle

Swallow bugs are not as prevalent as bed bugs, especially in suburban and urban areas, but they are certainly a viable species, formerly known as *Oeciacus vicarious.* As the name suggests, swallow bugs are usually found in barns, farm buildings, large warehouses, and storage sheds, although they can, and frequently do, take up residence on human habitats.

SWALLOW BUG
LOOKS LIKE A BED BUG

While bed bugs possess exceptionally flattened bodies (except when engorged with blood) with round abdomens; long, four-segmented antennae; and a small prothorax, swallow bugs can be distinguished from other, similar species by their antennae, the last two segments of which are the same length. Plus, swallow bugs tend to be grayish brown in color, whereas regular bed bugs are reddish brown.

BAT BUG, BED BUG, SWALLOW BUG COMPARISON

Wood Cockroaches
AKA Pennsylvania Wood Cockroach (*Parcoblatta pennsylvanica*)

WOOD COCKROACH (ULHER SPECIES)

Wood roaches do not thrive and reproduce in homes because they require the consistently moist environment of their natural habitats such as under wood piles or loose bark and in decaying logs. Indoors, their presence is strictly a temporary annoyance. They do not harm the house structure, furnishings or occupants.

Wood roaches can usually be identified by the presence of white stripes on the edges of the thorax and front portion of the wings. This characteristic is more readily apparent in the slender, straw brown-colored males than in the dark brown females and nymphs. The wings of the males extend slightly beyond the tip of the abdomen. The females' wings cover only half of the abdomen, and nymphs are wingless.

Wood cockroaches are a group of minor cockroach pests. They are native to North America. Males are usually plain brown and 1 inch or less in length. Females are shorter and broader than males. Generally, females range in color from light to dark brown, with wings only half the length of the body or shorter. Males are good fliers and are often found around lights at night. Sometimes males fly into buildings. Outdoors, wood cockroaches are found in areas such as wood piles, mulch, and leaf litter. Indoors, wood cockroaches cannot survive very well and are seldom a problem. This group of roaches causes occasional problems in homes and public places.

Topic 1 Living and Processed Wood Pests Quiz
Internet Link to Assignment…
http://www.abctlc.com/downloads/PDF/WoodDestroyersASS.pdf

Rot-Producing Fungi
1. Certain rot-producing fungi impart to _______________ which thus become symptomatic of weakness; however an attractive effect known as spalting produced by this process is often considered a desirable characteristic.

Water Content
2. Water occurs in living wood in three conditions, namely: (1) in the cell walls, (2) in the protoplasmic contents of the cells, and (3) as free water in the _____________ and spaces. In heartwood it occurs only in the first and last forms.

Wood Destroying Insects
3. Many insect pests are encouraged to take up residence in wooden structures by excessive ___________. Termites, particularly the dampwood termites and subterranean termites, require moisture in their living quarters.

4. The accumulation of termite fecal material in the nest, in turn, helps to promote the _____________________________ .

These “fungus beetles” include:
5. ______________________ —minute brown scavenger beetles.

Powder Post Beetles
6. The term powder post beetle, used in the broad sense, applies to any of the _________________________ of three closely related families (Lyctidae, Bostrichidae, and Anobiidae) within the superfamily Bostrichoidea.

Longhorned Beetles
7. Longhorned beetles are large (1/2 to 3 inches long), ___________ with long, thin antennae that may be longer than their bodies.

Black Carpenter Ants
8. Ants of the genus Camponotus often nest in wood. There are many different carpenter ant species, but only one poses a major pest problem (the ________________ (Camponotus pennsylvanicus).

Biology
9. Carpenter ants are among the largest species that you'll find. Like other ant species, carpenter ants are social, i.e., they live in a colony and have several "____________" or adult forms that perform different jobs in the colony.

Life Cycle
10. In the spring, carpenter ants swarm, i.e., ____________emerge from the colony. The swarmer's sole purpose is reproduction.

Answers
1. Wood characteristic colors, 2. Cell cavities, 3. Moisture conditions,4. Growth of the fungi, 5. Lathridiidae, 6. Wood-boring species, 7. Conspicuous beetles, 8. Black carpenter ant, 9. Castes, 10. Winged adults

Topic 2 - Termite Section

Topic 2 - Section Focus: You will learn the basics of wood destroyers with an emphasis on termites, including the life cycle, behavior and related scientific information. At the end of this section, you will be able to understand and describe general information about various termite species, including the life cycle and related information. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Topic 2 – Background: Termites cause more damage to homes in the United States than tornadoes, fires and earthquakes combined – over **$5 billion annually**. Costs due to termite damage to individual homes differ based on the degree and the length of infestation.

Termite Introduction

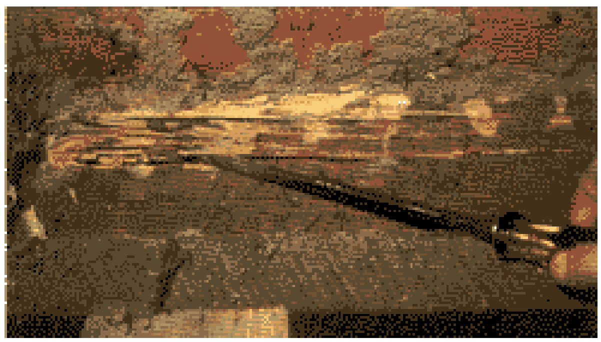
In the US, we primarily have four species of termites, Subterranean (Subs), Drywood, Dampwood and Formosan (FST). Formosan are a new invasive species. We will examine these species, ants and other wood destroyers in detail.

There are about 2,500 termite species in the world. North America has 42 different termite species, most of these are located in the southeast USA. Alaska is the only state without termites. Incredibly, Florida's eastern subterranean termite colonies have about 250,000 members, but can have 1 million or more.

An average termite colony eats about 1 cubic foot of wood a year. That amount may seem small, but generally speaking, homeowners are unaware of damage for many years. The termite queen can lay up to 2,000 eggs per day and live as long as 50 years.

Termite damage to residential and commercial buildings in the U.S. costs more than $5 billion annually. This amount does not include the cost of termite control. Subterranean termites, the most destructive of all termite species, account for 95% of the damage.

Two subterranean termite species, Reticulitermes flavipes (reference Kollar) and R. tibialis Banks, are commonly found in United States. Control of these termites' costs more than $50 million each year, an average of $8,500 per home and is the reason you are studying this course. This CEU course focus is for you to master termite management/control / inspection / identification methods.



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

Feeding Habits
Termites feed primarily on wood and wood products containing cellulose. Termites have special protozoa (microorganisms) in their intestine that provides enzymes to digest cellulose. This relationship is beneficial to both species, since the protozoans cause no harm and are provided with food and a protected environment by the termites. There is no way that these insects can live without these protozoa, and no way for these bacteria to survive without the termites.

Although termites are soft-bodied insects, their hard, saw-toothed jaws work like shears and can bite off extremely small fragments of wood. Termites often infest buildings and cause damage to lumber, wood panels, flooring, sheetrock, wallpaper, plastics, paper products, and fabric made of plant fibers.

Termites attack flooring, carpeting, artwork, books, clothing, and furniture. The most serious damage involves the loss of structural strength. Most termites do not attack live trees, except for the Formosan and Dampwood termite. Dampwood prefer to feed on live trees – but wood that is under ground level notably citrus.

General Colony Information
There are two basic concepts of were the colony is located. Most of the time and for most of the termite species the colony is below ground.

Below Ground Termite Colonies
Subterranean termites are ground-dwelling social insects living in colonies. The two species of Subs found in United States have similar habitats. These termites have the ability to adjust the depth of their colony (nest) in soil depending on temperature and moisture requirements. The colony may be up to 18-20 feet deep in the ground.

SUBTERRANEAN TERMITES

The ground serves as a protection against extreme temperatures and provides a moisture reservoir. Termites reach wood or cellulose materials above ground by constructing and traveling through earthen (mud) tubes. It takes about 4 to 5 years for a colony to reach its maximum size and it may consist of 60,000 to 200,000 workers.

Above Ground Termite Colonies

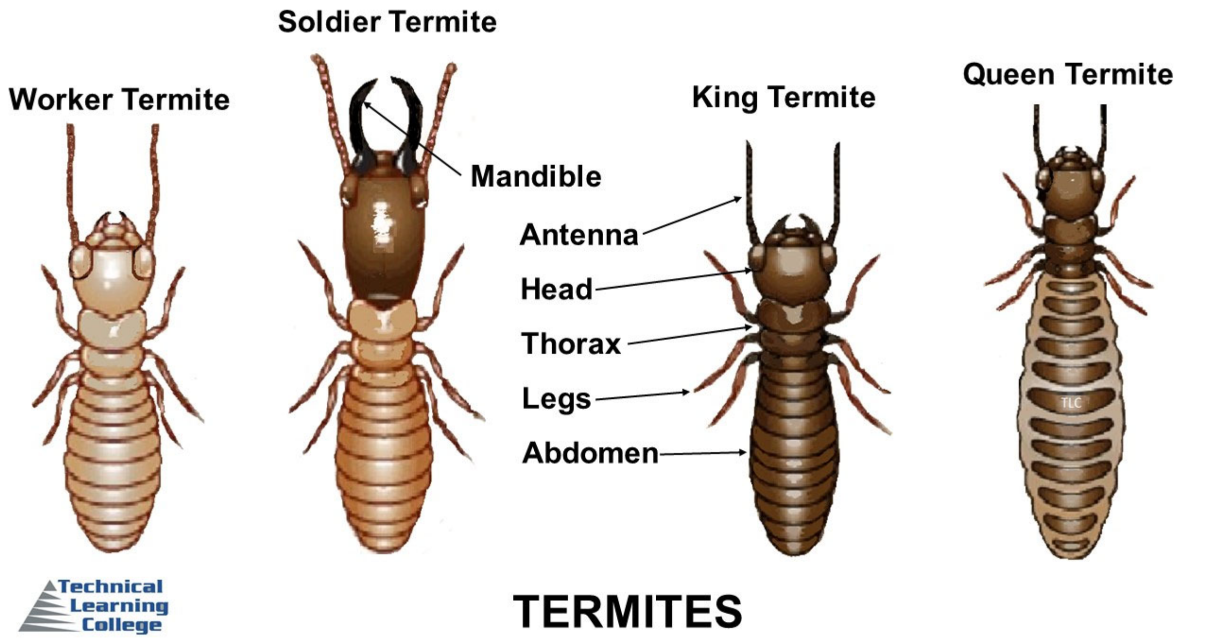
In the United States, drywood termites can be found in a narrow strip that runs roughly from **Florida to California** − warm to tropical climates where wooden structures are plentiful and winters are not severe. A drywood termite likes to eat. And unlike its subterranean counterparts, it does not need moist soil or water nearby in order to thrive.

Drywood termites do not need a connection to soil and there is no soil in their feeding galleries. They do not build mud tunnels; they construct large, irregular galleries that run across and with the wood grain, with a very smooth, clean, and sandpaper-like appearance.

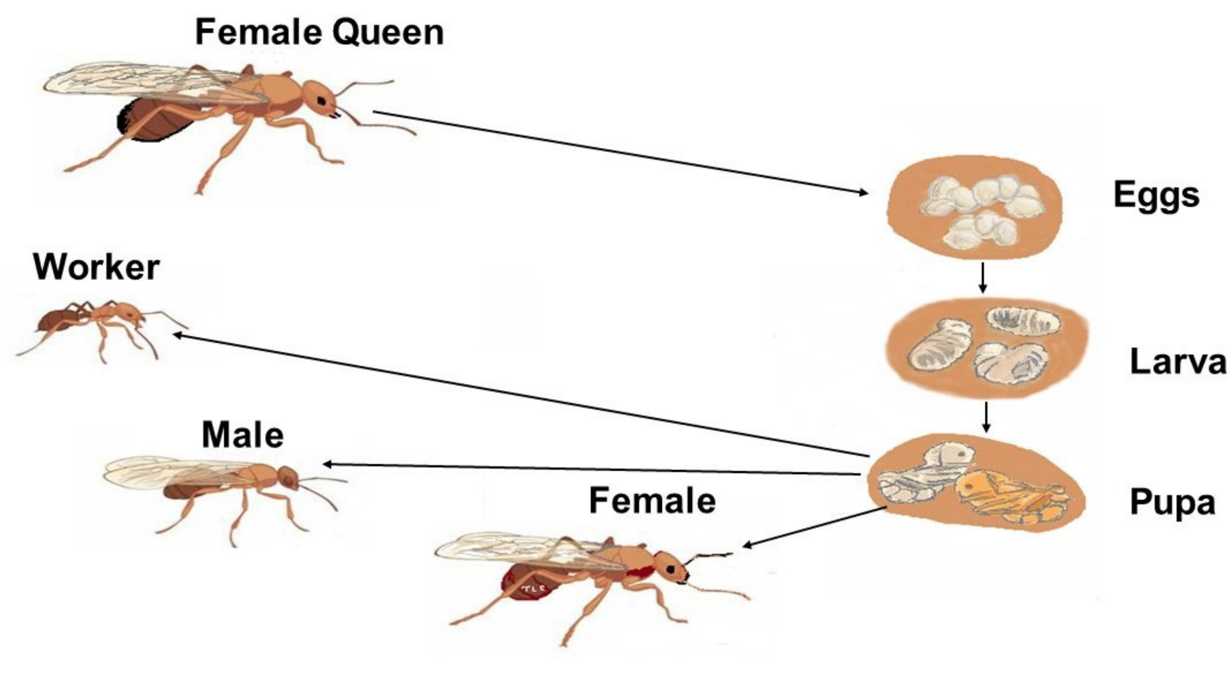
DRYWOOD TERMITE DAMAGE EXAMPLE

The galleries are connected by openings small enough for one termite to pass through. The sure sign of drywood termite feeding is their fecal pellets that are ejected from the galleries via kick-out holes, often found right below the damaged wood. These pellets are quite unique and are hard, elongated-ovals with rounded ends, and have six concave sides.

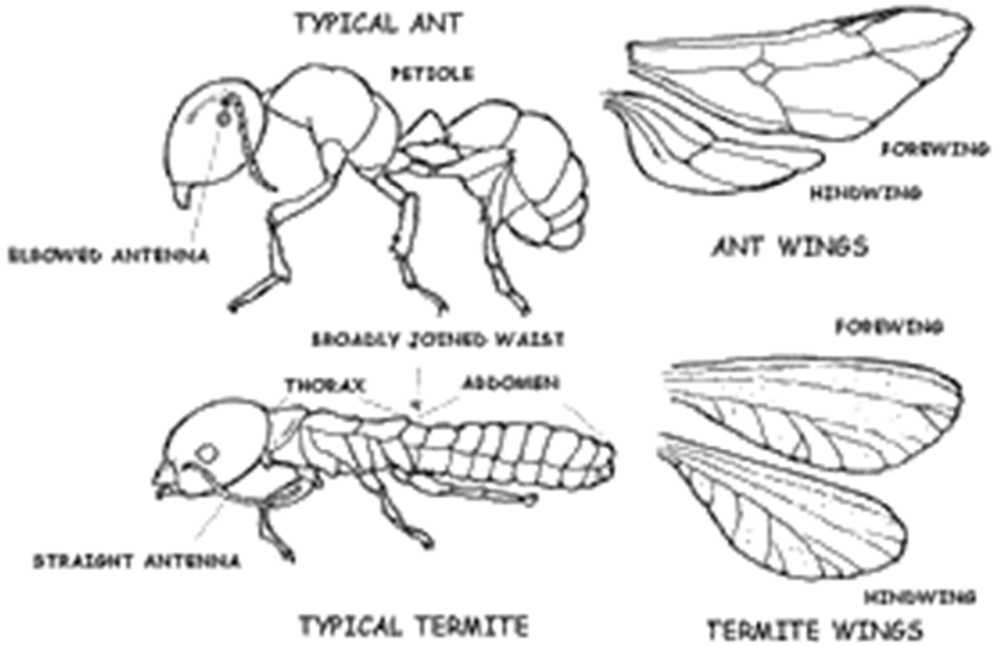
We will cover this area more in detail in the inspection portion of the course.

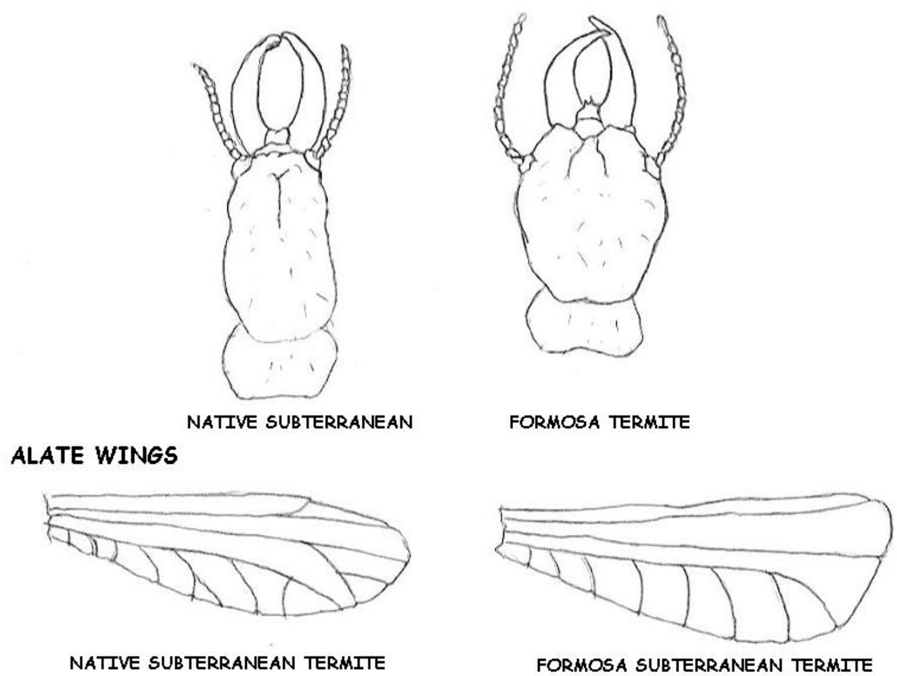


TERMITES



ANT LIFE CYCLE DIAGRAM

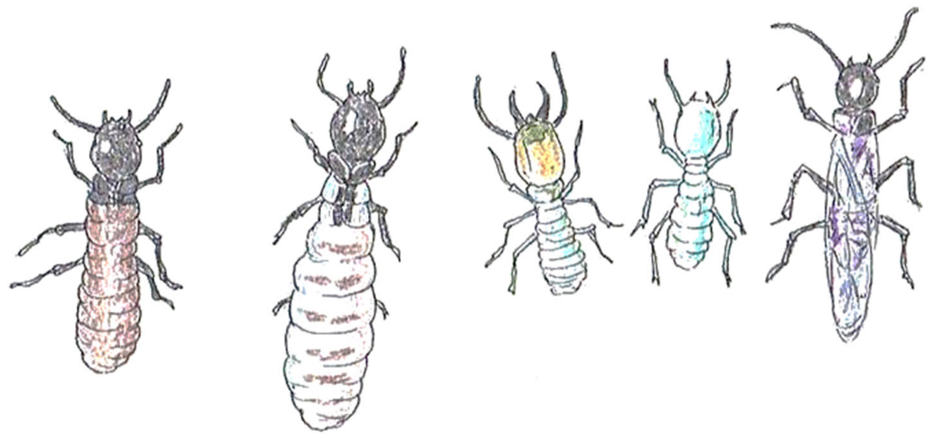




TERMITE SOLDIERS

Termite Biology

Caste Definition
A group of insects with a specific morphology and function within a colony of social insects.



MALE REPRODUCTIVE FEMALE REPRODUCTIVE SOLDIER WORKER WINGED REPRODUCTIVE

TERMITE CASTES

Most termite species have four castes, King and Queen (reproductives), Soldiers, Workers and Nymphs. There is an exception to this system; the Nevada dampwood termites have three primary castes: nymphs, reproductives and soldiers.

Reproduction
Generally speaking, there are minor differences with the species, in spring and fall, the winged males and females emerge from their parent colonies to form new ones. This activity is called swarming. These winged reproductives are dark brown to brownish black and have two pair of nearly equal size semitransparent wings extending well beyond the body. The swarmers are weak flyers and, unless aided by wind, fly only short distances. Many of them are devoured by birds, spiders, ants, and other predators.

Survivors return to the ground and shed their wings. The wingless males and females pair off (male following female in tandem) until they find a source of wood and moisture in the soil. They dig soil near wood, enter the chamber and seal the opening. After mating, the queen begins laying eggs. The royal queen is known to survive up to 50 years in some termite species and others up to an average life span of 25 years. We will cover this later in the different species differences.

Eggs
Generally speaking, the fertilized Sub female (queen) usually deposits 6 to 20 eggs during the first six months following the swarming flight and she may lay more than 60,000 eggs in her lifetime. Eggs are yellowish white and hatch after an incubation period of 50 to 60 days.

TERMITE EGGS

Workers
The first broods of newly hatched nymphs (young termites) generally develop into workers. Full-grown workers are soft-bodied, wingless, blind, and creamy white. In early stages, they are fed predigested food by the king and queen. This first feeding also provides the bacteria to help these creatures digest their food.

Once workers are able to digest wood, they begin providing food for the entire colony. At this time, the king and queen cease feeding on wood. The workers undertake all the labor in the colony such as obtaining food, feeding other caste members and immatures, excavating wood for chambers, and constructing tunnels. Workers mature within a year and live from 3 to 5 years.

Soldiers
Generally speaking, there are minor differences with the species Soldiers are creamy white, soft-bodied, wingless, and blind. The head of the soldier is enormously elongated, brownish, hard, and equipped with two strong jaws.

Soldiers must be fed by workers as they are incapable of feeding themselves. They are less numerous than workers and their sole function is to defend the colony against invaders such as ants. Soldiers mature within a year and live up to 5 years.

Differences between Ants and Termites

Body shape: A termite has no "waist," instead, its body is more rectangular, without any narrowing in the center. In contrast, the carpenter ant has a very well-defined narrow, constricted waist.

Antennae: An insect's feelers can say a lot about the insect, too. A termite has straight, beaded antennae, meanwhile, a carpenter ant's antennae are bent or "elbowed."

Wings: Both insects are winged creatures and each has four wings. A termite has wings that are of equal size and shape and its wings are much longer than its body. A carpenter ant's back, hind wings are shorter than its front forewings and the wings do not look unusually long or disproportionate to its body. Another thing with termites is that their wings are not as durable as ants. The wings of the termite fall off easily. The loose wings can often be seen near the opening of a termite nest and can be used to identify a termite infestation.

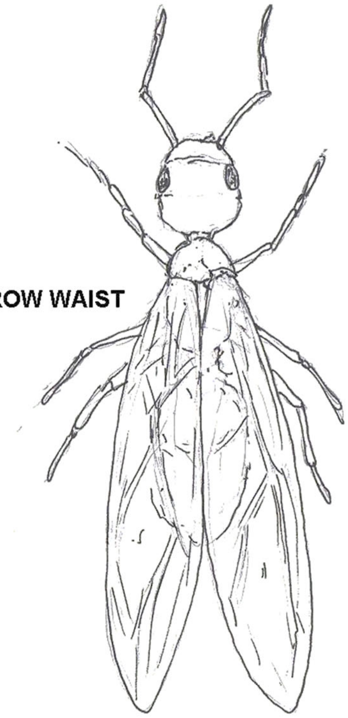
Color: Ant workers are reddish or dark-colored and are frequently seen in the open foraging for food. Termite workers, by comparison, are transparent, light or creamy white in color, and they avoid light. Termites are rarely noticed unless their nest is disturbed.

Characteristics	Ants	Termites
Active Reproductives	Queen(s)	Queen and Kings
Antennae	Bent or "elbowed	Straight, beaded
Wings	Hind wings are shorter than its front forewings	Equal size and shape
Parthenogenesis	All Species	Never
Larval Stage	Yes	No
Eye Sight	Most Species	Workers are blind
Build Earthen "Ant Nest"	Rarely	Most Species
Carnivorous	Most Species	Very few species
Grow Fungus "Gardens"	Very few Species	Most Species

Flying ants and swarming termites are often difficult to distinguish when these insects are seen around residential and commercial buildings. The main enemy of termites are Ants and the Soldiers can defend against a small number of Ants.

ELBOWED ANTENNAE

NARROW WAIST

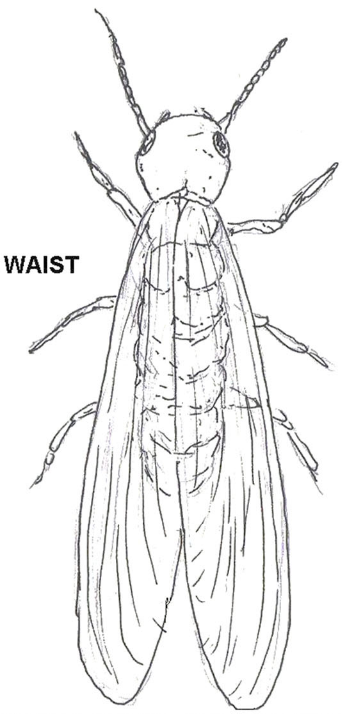


WINGED ANT

FRONT WINGS LONGER THAN BACK
(1/2 inch IN SIZE)

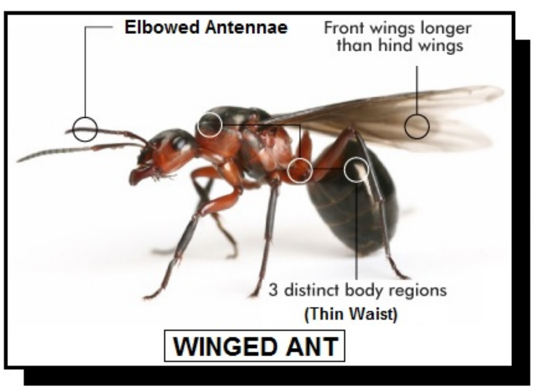
STRAIGHT ANTENNAE

THICK WAIST

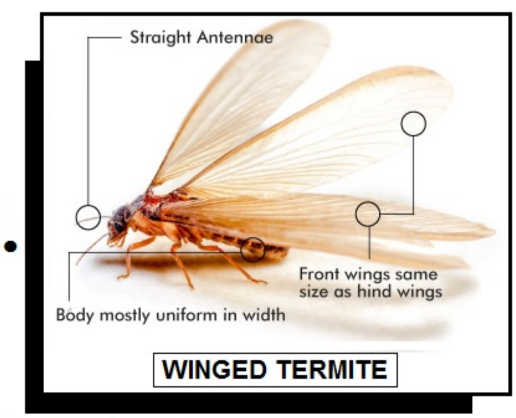


WINGED TERMITE

BOTH PAIRS OF WINGS SAME SIZE
(1/2 inch IN SIZE)



VS.



WINGED TERMITE / WINGED ANT COMPARISON

Technical Learning College

Termite Life and Reproduction

More on Reproduction
The female (queen or winged reproductive) assumes a "*calling*" position with her abdomen elevated at a right angle to the rest of her body. She releases a chemical messenger (pheromone) which attracts nearby males. Once a male encounters a calling female, she moves off. He follows close behind and they search for a suitable site for the establishment of a nest. As soon as the pair has located a suitable site, they excavate (with their jaws) a small chamber large enough for the two of them and then seal the entrance. Mating usually occurs within a few hours to weeks after the pair becomes established.

TERMITE QUEEN – SOLIDER AT HER FRONT

The single female cannot start a new colony on her own, as some ants are able to do. Establishment of a termite colony is dependent upon the survival of both sexes in the nest site and that she has successfully mated. The pair continues to live together for life, and they usually mate periodically. The first eggs are laid within one to several weeks after mating, depending on the nutrition available to the female. When the first eggs hatch, the new nymphs are cared for by the young pair. After two molts, the nymphs assume their role as workers and begin to feed and care for the original pair.

Development of the Colony

Development of the colony is very slow for several years. Eggs are not deposited continuously. After the first group of eggs has been laid, there is a period of several months before another group is laid. This process continues for several years. As the young queen matures, she lays a greater number of eggs, and her abdomen becomes enlarged from developing eggs. Eventually, a point is reached where the colony size stabilizes. That is, the queen has reached maximum egg production, and the loss of older individuals by death or swarming is approximately the same as the number of new individuals produced each year.

As the colony becomes mature, a greater number of swarmers are produced each year. It requires a minimum of 3 to 4 years--and as much as 8 to 10 years--for a colony of our native subterranean termites to become large enough and strong enough to start dispersal flights.

Swarming

When swarming occurs in a relatively new structure, it is because it was built over or near a strong colony that was not severely damaged during the construction process. Termites derive food from wood and other cellulosic materials. Again as earlier, in nature, they feed exclusively on wood, primarily digesting out the cellulose and passing most of the remaining components as waste.

TYPICAL TERMITE SWARM –USUALLY AFTER A RAIN

In man-invaded environments, termites attack many additional products and commodities. They still depend primarily on cellulose for their nutrition, but will damage many materials they encounter. Damaged materials may include plastics, rubber, asphalt, metal, mortar and others. Wood products like paper are favorite foods of termites because they are nearly pure cellulose. Cotton, burlap and other plant fibers are actively consumed by termites as well.

Fungi
Fungi also play a primary role in termite nutrition. Certain wood decay fungi are highly attractive to termites. Partially decayed wood is more easily digested by termites, and the fungus provides a needed source of nitrogen. Ultimately, wood-destroying fungi exhaust the nutritive value of wood for termites, and extensive decay in wood is of no benefit to foraging termites. Conversely, when termites attack wood, they usually bring fungus spores on their bodies. When water or other liquid reaches the damaged wood, it is more easily trapped.

TERMITE FUNGUS

Moisture
Moisture is vital to the survival of termites. Subterranean termites obtain most of their moisture from the soil. They maintain contact with the soil in order to survive. The type of soil has a great effect on the ability of subterranean termites to flourish. They generally prefer sandy soil over a clay base. They can and do survive in many other types of soil, however.

Tolerances
Generally speaking, most termite species have very little tolerance to dry conditions, or extremes of hot and cold. But they often must forage far, sometimes above ground, from their initial workings to find food. They move underground through tunnels. Whenever the termites leave the confines of the soil or the wood in which they are feeding, they construct shelter tubes in which to move from the soil to the wood or the above-ground nest.

Subterranean Termites
When subterranean termites invade the wood of a structure that is separated from the soil by intervening concrete, masonry or other impervious material, they construct shelter tubes (mud tubes) over the surface to the wood. Periodically, they return to the moist galleries.

Contrary to published reports, shelter tubes do not necessarily conduct moist air from the soil to the wood. Shelter tubes also provide some protection from air movement and prevent excess water loss. The primary function of shelter tubes probably is protection from natural enemies. Once termites have established contact with wood above ground and feeding progresses some distance from the initial shelter tunnel, they often will drop shelter tubes straight down from the wood. Evidence of tube building will be found directly below a suspended tube.

Castles
Under certain conditions, a fourth type of tube is constructed. Called swarming tubes or swarming "*castles*" they are constructed as flight platforms for swarmers and they have many turret-like projects and flattened horizontal branches that vaguely resemble castle towers. They usually are constructed on the ground to a height of 4 to 8 inches, but sometimes are found projecting from heavily infested wood above ground.

SWARMING TUBE

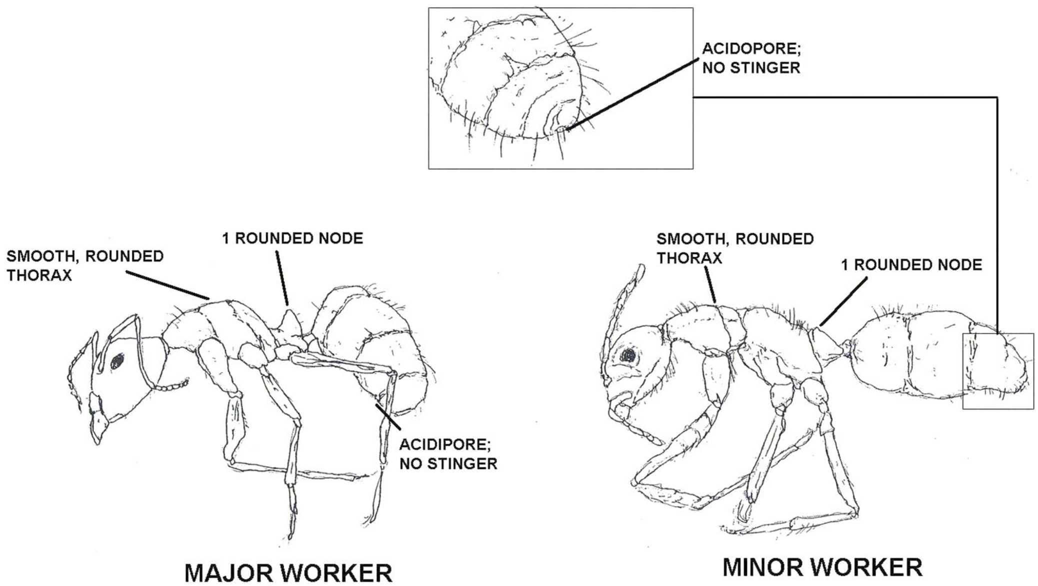
When swarmers are leaving the colony via these tubes, or directly through a hole in wood or soil, the openings are heavily guarded by soldiers and workers. The amount of damage that an infestation of subterranean termites might inflict on a structure depends on many factors. The number and size of the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

Damage usually starts at the mudsill in houses built over a crawl space and with the sole plates of those houses built on concrete slabs. Given enough time, subterranean termites will extend the damage into the wooden floor members, the interior trim and furnishings, and into the walls up to the roof timbers.

Damage
Severe damage by subterranean termites is not likely to occur in the first 8 or 10 years after construction. If treatment is undertaken with the first evidence of infestation, very little serious structural damage is ever likely to occur. Houses should be carefully inspected at least once a year in all regions. This will allow detection before damage is a problem. Should *evidence of termites be found, there is no cause for extreme alarm or undue haste.* Treatment within 3 months is highly recommended.

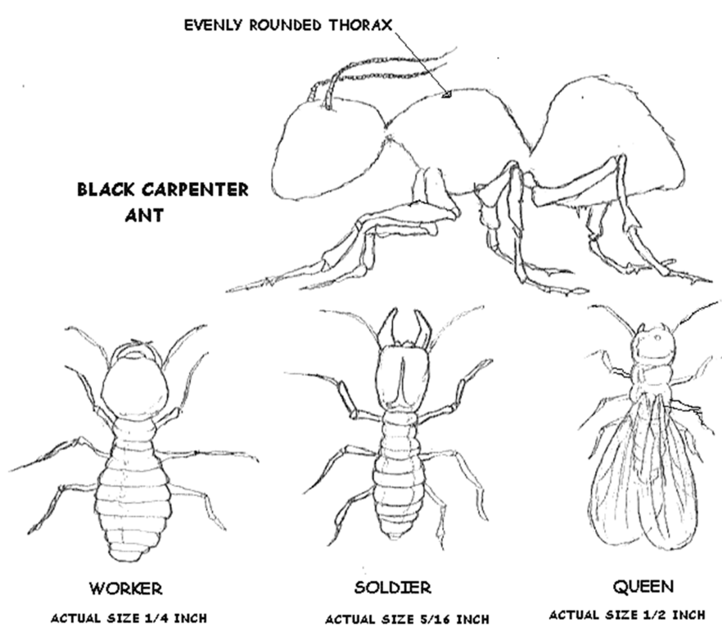
Communication in the Colony
1. Termites primarily communicate via pheromones. Each colony develops its own characteristic odor. Any intruder is instantly recognized and an alarm pheromone is released that triggers the soldiers to attack the intruder. If a worker finds a new source of food, it recruits others to that food source by laying a chemical trail. The proportion of castes in the colony is also regulated chemically. Again, nymphs can develop into workers, soldiers, or reproductive adults, depending on colony needs.
2. Sound is another means of communication. Soldiers and workers can bang their heads against tunnel walls. The vibrations are perceived by other termites in the colony and serve to mobilize the colony to defend itself.
3. Mutual exchange of foods enhances recognition of colony members.

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



Carpenter Ant Identification

If you tear the legs off an ant, you'll have a snowman. Not so with a termite**,** you'll have a head and a long body. Termite swarmers have straight, bead-like antennae; a thick waist; and two pair of long, equal-length wings that break off easily. Winged termites can be differentiated from winged ants, which have elbowed antennae, a constricted waist, and two pair of unequal-length wings (forewings are larger than hind wings) that are not easily detached. Ants also generally are harder-bodied than termites.



Differences between the 2 Primary Termite Species

	DRYWOOD TERMITES	SUB TERMITES
FOOD	CELLULOSE (derived from wood and wood based products.)	CELLULOSE (derived from wood and wood based products.)
MOISTURE	No outside moisture needed. Can survive on a small amount of moisture within wood.	Require an outside moisture source. This may be from the soil, leaky plumbing, roof tops, etc...
ENVIRONMENT	Colonies live within the wood and do not require contact with the soil.	Normally live and forage in the soil. Can establish a nest above the soil if an acceptable moisture source is found. Build protective mud tubes that lead from the soil to the home. Can move colony within soil when environmental conditions require.
COLONY SIZE	SMALL (few hundred to a thousand termite members.)	LARGE (A well-established colony may contain over 7 million termites. Some species have numerous smaller colonies of several thousand termite members.)
EVIDENCE OF ACTIVITY	"Sand-Like" pellets or "droppings". Kick-out holes on the walls, ceilings or wood. Infestation may take two years before evidence of droppings is present.	1) Mud Tubes ascending from the ground to the structure or protruding from walls and/or trim. 2) Heavy termite swarming within the structure 3) Slits in the wood (flight slits) 4) Uncharacteristic waviness in the wood.
PREVENTIVE MEASURES	1) Use treated lumber during construction. 2) Coat any untreated wood or exposed wood end cuts with an appropriate termiticide. 3) Seal all cracks and crevices with caulking.	1) Install a termite monitoring or detection system at the home or structure. 2) Perform treatment to the soil before construction with an appropriate termiticide. 3) Eliminate conditions conducive to infestation.

CONTROL MEASURES	Light Activity: 1) locate kick-out holes	**Prevention through education, detection and

	2) lightly puncture kick-out hole 3) inject appropriate insecticide in kick-out hole. 4) Seal kick-out hole with caulk. Heavy Activity: Tent fumigation	elimination of conducive conditions are the most effective and cost efficient control measures. When activity is already present, treat the structure with a liquid termiticide.
DAMAGE LEVEL	Minimal* * When compared to subterranean (ground) termites. Takes up to two years for evidence of activity to be present.	Some species of subterranean termites can consume 15 pounds of wood per week.

Alates - Below is listed a comparison of Formosan alates and the three common native subterranean species.

	Formosan	R. flavipes	R. virginicus	R. hageni
Body Size	12-15 mm (0.5 – 0.6 in.)	8-10 mm (0.3 – 0.4 in)	4.5-5 mm (0.1 – 0.2 in)	4.5-5 mm (0.1 – 0.2 in)
Body Color	Light yellow-brown	Black	Black	Light yellow-brown
Wings	Covered with fine hairs	No hairs	No hairs	No hairs
Wing size	> 11 mm (0.4 in)	8-9 mm (0.3 in)	6.5-7.5 mm (0.25 in)	6-7 mm (0.2 in)
Flight times	May – July Night	Feb – April Day	May-June Day	August Day
Antennal Segments	Greater than 20	Less than 20	Less Than 20	Less than 20

Winged dampwood termite Alate.

Winged "sub" Alate.

Termite Specific Identification Section

Subterranean Termites

Western Subterranean Termite *Reticulitermes hesperus*

The western subterranean termite, *Reticulitermes hesperus,* is native to most forest areas where it performs the important task of breaking down the large quantities of dead and fallen trees and other sources of cellulose that continuously accumulate in the forests.

WESTERN SUBS ON FALLEN TREE

The Western subterranean termite is one of the most destructive termites in North America. It is a serious economic timber pest causing millions of dollars of damage throughout the areas where it is located. It is estimated that more than 1 in 5 homes in the high risk activity areas, been or will be attacked at some time by these voracious little insect. Unfortunately, they also attack wooden structures and, if left uncontrolled, will cause weakening and collapse of the structures due to their feeding activity. Other wood products can also be attacked under the right conditions. The presence of termites in buildings is cause for concern not only from the standpoint of safety but also in terms of the cost of preventing further structural damage and replacing damaged wood.

The Western subterranean termite is the most common and most widely distributed termite in the western half of North America. It is a problem for homeowners from British Columbia in Canada, south to western Mexico and east as far as Idaho and Nevada.

Western subterranean termites are in plague proportions in central and southern parts of California, particularly in the older urban areas of the San Francisco Bay Area, Sacramento, Reno, Fresno, Los Angeles, Orange County, San Fernando Valley and San Diego.

This native American pest can enter structures through cracks less than 1/16 of an inch wide, even the minute openings found in concrete slabs, around drain pipes, and between the slab and the foundation.

Western subterranean termite colonies are usually located in the ground below the frost line, but above the water table and rock formations. They are typically detected by the presence of the mud tubes they construct, or when large numbers of winged termites "swarm" or leave the colony to search out mates. Swarms occur in the daytime, and in California, they occur on warm, sunny days during the fall, winter or early spring. In the northern sections of the termites' range, spring swarms commonly occur in the absence of rainfall.

Western subterranean termites are highly destructive to Douglas fir and other common building timbers. Western subterranean termites rapidly eat out the internal sections of structural timbers - devouring mainly the spring wood, and preferring to leave the harder summer wood sections.

Western subterranean termite workers look like white or cream-colored ants. Soldiers have an orange, rectangular-shaped head with large pincher- like mouthparts that are used to fight off colony invaders. Swarmers are about 3/8-inches long (wings included), and their body is dark brown. They have two pairs of wings, and the front wings are larger than the hind wings.

Thin Honeycomb Shell
Western subterranean termite infested timbers are often left as a thin shell with a honeycomb of layered hollow sections (as illustrated on left) packed with a composite of partly digested timber and soil extract. If this soil timber composite is moist, chances are you'll also find live termites close by. Western subterranean termites prefer a moist dark damp environment - it is essential for their survival.

Social Interdependence
Within a termite colony there are members of different castes, each with a different role to perform and all interdependent upon each other for the survival of the termite colony. The different castes include the queen, king, the winged reproductives (young kings and queens), soldiers and worker termites.

Biology and Description
The western subterranean termite is a social insect, living in colonies that have just a few thousand to sometimes millions of individuals. Each colony will include reproductives, workers and soldiers. Winged reproductives emerge in a mass nuptial flight in April and May. These flights are often the first indication homeowners have of termite infestations. A small emergence may occur in late summer.

Reproductives are about 5-6 mm long and are often confused with winged or '*flying*' ants because of their black bodies and transparent wings. The following figures illustrate how to distinguish between the two types of social insects. The waist of ants is narrow whereas termites have a broad waist between the thorax and abdomen. The antennae of ants are elbowed whereas those of termites are straight with bare bead-like segments.

Ants have two pair of transparent wings with few veins and are not of equal length, and often have a dark patch along the outer margin of the front wing, whereas the wings of termites are about equal in length (8-9 mm) and have many fine veins.

Courtship Run
After flight, males and females will break off their wings, form tandem pairs that have a courtship run on the ground, and then together seek a suitable site to begin a colony--in wood buried in the ground or laying on the surface of damp ground. The initial rate of colony growth is slow, however additional egg-laying females are produced which increase the rate of colony development. Large colonies will subdivide if food sources are abundant. Winged adults do not appear until the colony is 3 or 4 years old, then mass emergences will occur each year.

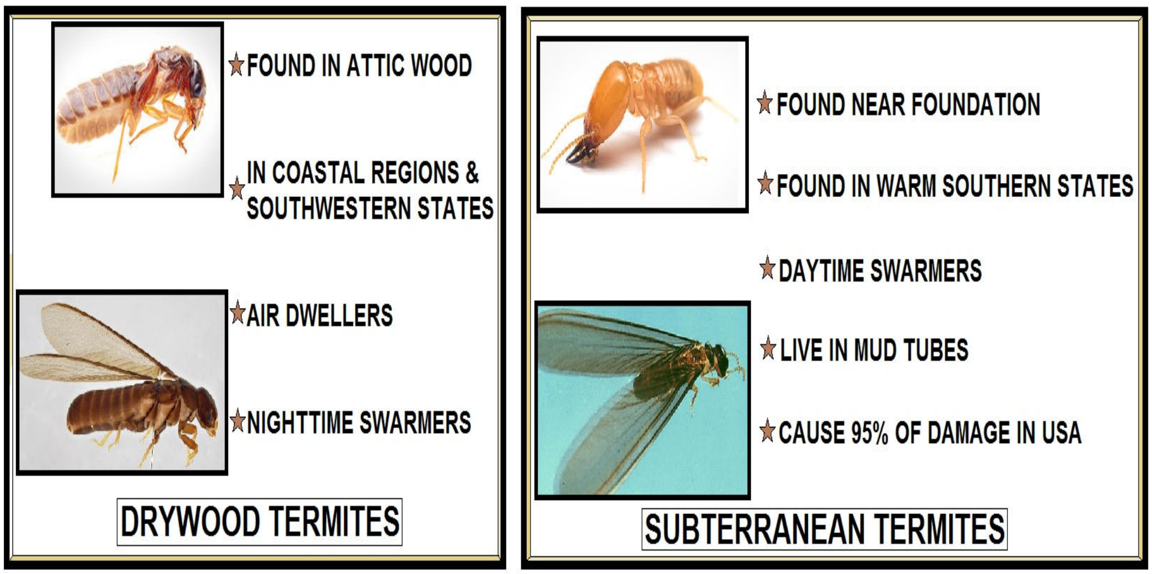
Worker Termites
Worker termites are ¼ inch (6 mm) long and pale cream in color (worker ants are yellow, red, brown or black); soldier termites are the same size and color; however, their heads are enlarged (almost half their body length) with noticeable black jaws.

WESTERN SUB SOLIDER NEXT TO WORKER

Soldiers will tap their heads against the wood when disturbed which is another means of detecting the presence of termites. Workers construct the distinctive shelter tubes and collect food to feed the young and other members of the colony. Soldier termites are responsible for guarding the colony and its occupants. Termites continually groom each other to obtain certain secretions. These secretions help regulate the number of individuals in the various castes.

Identification Tips Western Subterranean Termite - Soldier Caste
The Western Subterranean soldier termites have an orange colored rectangular armored head with mandibulate pinchers which they use to crush member of the ant family - their arch enemy in the insect world. The Western subterranean termite soldier has a fontanelle (frontal gland pore or hole) on their forehead used to squirt a white sticky latex, mainly as a defense mechanism against ants.

The soldier termite is usually the first to be seen in large numbers when any active termite workings (mud shelter tubes or damaged timber) are opened. Soldier termites will rush out to guard the opening whilst worker termites repair the breach.



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DRYWOOD / SUBTERRANEAN TERMITE COMPARISON

Termite Alate Swarmers (or reproductives) are commonly seen when they swarm during daylight; they have eyes; are poor fliers but are swept along by the wind; they land, drop their wings, find a mate to become king and queen of a new termite colony.

Western Subterranean Termite Identification Tips - Alate Caste

The western subterranean termite swarmers are about 3/8" long (including wings) with a dark brown body and a small fontanelle (frontal gland pore) on its head. Their wings are brownish grey with two dark solid veins along the forefront of the front wings. The front wing is distinctly larger than hind wing.

Swarming
In the northern part of their range, swarming takes place in the spring, but without rain. In the southern areas, swarming usually follows rain. The swarmers are emitted in their thousands when a mature termite nest is large and well established.

Western subterranean termites swarm in large numbers over a wide area to find a mate from another colony nest to start up a new colony. A suitable location for nesting should provide moisture and a readily available timber food source close by.

During the warmer months you may see the flying alates (winged reproductives) caste take to the air and swarm in their thousands, in order to meet up with swarmers of other nests in the area so they can establish new termite colonies in the local area. This is a sure DANGER sign that a large mature termite nest is close-by. Such a nest may contain hundreds of thousands of Western subterranean termites within range of infesting the timbers in your home.

Colony Information
Colony nest development is slow in the first few months, with the egg-laying capacity of the new queen termite peaking after a few years. The swarmers are emitted in their thousands when a mature termite nest is large and well established. Swarmers are usually produced after this period and are an indication a large termite nest is in the vicinity, a sure danger sign and a warning that professional treatment is required.

The colony nests of Western subterranean termites are usually located in the ground below the frost line, but above the water table. Mud galleries or "shelter tubes" are constructed across hard objects in order to gain access to timber food sources.

Western subterranean termites constantly search for new food sources. They are known to enter buildings through cracks in concrete flooring or to travel under parquetry or tile flooring through gaps of less than 1/16" wide.
Where moisture regularly collects inside the wall or other cavities of a building, possibly from faulty plumbing or broken roof tiles, the Western subterranean termite can develop a subsidiary colony nest that may not require contact with the ground to ensure its survival.

They build a central colony nest from which they construct underground tunnels that radiate within a 100-yard radius from a central colony nest in search of a timber (cellulose) food source. Western subterranean termites travel in these mud shelter tubes as protection from predators, sunburn, dehydration and to maintain a high humidity environment that is essential for their survival.

Western subterranean termites are highly secretive, preferring to enter a building through areas inaccessible to inspection, such as, through in-fill patios, fire heaths, expansion joints and cracks in concrete slab (on-ground) flooring.

Western subterranean termites can pass through a 1/8" crack or an expansion joint (eating through the rubber compound) between adjoining concrete on ground flooring. Western subterranean termites can also travel under timber parquetry and other floor tiles to get to the wall framing timbers in a building.

Western subterranean termites have acute survival instincts. If they are shaken up or disturbed, the termites often will abandon the associated area and move on to secretly cause damage in other areas in the building.

SOLIDER SURROUNDED BY WORKERS

Desert Subterranean Termites

Have you been to the desert and seen a piece of wood that looks normal until you pick it up and the board is nothing but a hollowed out shell? Desert subterranean termites are commonly distributed throughout the lower deserts of northwestern Mexico, southern California and southern Arizona.

DESERT SUBTERRANEAN TERMITES

Here are a few important facts you should understand about the life and behavior of desert subterranean termites, compared to the more common Eastern or subterranean termites such as Formosan or Eastern subterranean:

- Desert subterranean termites are able to survive in drier conditions than Formosan or Eastern subterranean termites.
- Soldiers of desert subterranean termites are characterized by their slender and straight mandibles, in contrast to the relatively thick, curved mandibles of Formosan or Eastern subterranean termites.
- Their small size and ability to forage under dry conditions allows them to occupy a niche not exploited by other subterranean termite species.

- Preliminary research suggests that baiting for desert subterranean termites requires more time than for others. Given the small size of desert subterranean termite soldiers and workers, they are apt to penetrate smaller cracks in concrete and masonry that are too narrow for foragers of other subterranean termites to enter.
- Subtle differences in foraging behavior do exist. Foraging tubes are lighter in color, narrower, and more circular. Sometimes, desert subterranean termites will openly build very narrow, free-hanging tubes from ceilings, shelves and overhangs.
- Don't be surprised to see tubes as long as 6 to 12 inches in length. These tubes are often re-used by desert subterranean termites.

Identification of Swarmers and Soldiers
The Desert subterranean termite swarmers are about 3/8" long including their wings. Their body is a pale yellowish brown and a fontanelle (front gland pore) is indistinct or absent. The wings have two prominent hardened veins in the front portion. The wing membrane is translucent, almost colorless, with a few barely visible hairs. The front wing is larger than the hind wing.

The head of the Desert subterranean termite soldier is rectangular in shape, the length about twice the width. It also has a fontanelle (front gland pore) on the forehead. The body (pronotum) is flat and almost as wide as the head.

The Desert subterranean termite soldiers have long powerful pointed jaws (mandibles) that are slender, fairly straight but slightly curved inward at the tip. This contrasts with the mandibles of the Western subterranean termite that are thick and curved.

The small size of Desert subterranean termites and their ability to forage under dry conditions allows them to occupy a niche not exploited by other subterranean termite species.

Identification of Timber Damage
Desert subterranean termites prefer to eat the springwood in timbers, generally avoiding the lignin in summerwood. Damaged timber appears honeycombed, with soil in the galleries.

The Desert subterranean termite is less dependent on moisture and decay than other subterranean termites. It will readily attack dry, sound wood. A typical sign of infestation is the presence of “drop tubes” coming from the ceiling rafters and sheetrock/plasterboard and/or holes in the sheetrock plugged with feces.

Identification of Mud-Shelter Tubes
Desert subterranean termites prefer to forage in shaded soil or areas made wet by irrigation. They will readily construct mud shelter tubes up, over or around solid objects in order to reach a timber food source. These mud-tubes are slender, solidly built and pale yellow to tan in color. Desert subterranean termites’ mud-tubes are more circular in cross section than those of the Western subterranean termite whose mud-tubes are flattened in cross section and dirty light brown in color.

Biology and Habits
Desert subterranean termites most often swarm at night during the rainy season, from July to September, usually after rainfalls. The moist soil provides the nuptial Desert subterranean termite swarmers with the best chance of surviving and developing a new colony. The male and female pair off and enter the soil where they excavate a cavity or cell.

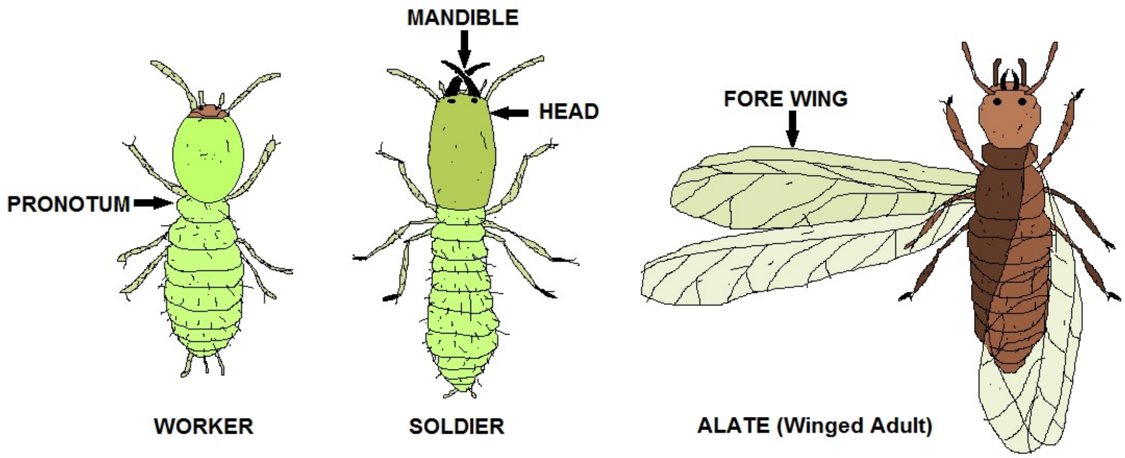
A well-developed mature colony of Desert subterranean termites may contain more than 300,000 termites, including a large number of secondary reproductives (queens) that can readily break off from the primary colony to form separate colonies. Desert subterranean termites commonly have a foraging territory of up to almost an acre.

Desert subterranean termites require only a tiny gap, about 1/32", in concrete flooring or mortar joints in brick walls to gain access to the wall, roofing and other structural timbers in a building.

The Desert subterranean termite can penetrate cracks in concrete and masonry that are too narrow for foragers of other subterranean termite species to enter. Desert subterranean termites often build their mud-shelter tubes as freestanding tubes that "drop down" from rafters, ceilings and subfloor areas under buildings.

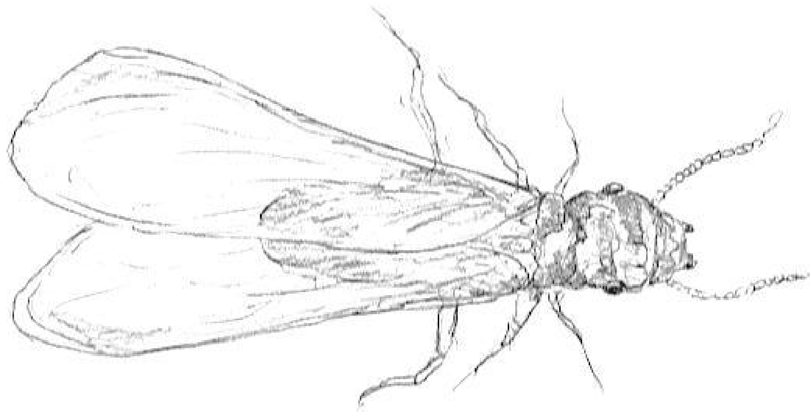
Some quick facts about Western Subterranean Termites

- Although Western subterranean termite colonies are largely located in the ground, secondary colonies can exist above ground if there is a constant source of moisture.
- Western subterranean termites will often build mud tubes for travel between their colonies and their food sources.
- Damage caused by Western subterranean termites is most commonly found in the basement and at ground level, although the termites will attack wood at higher levels.
- Development from eggs to adults may take more than 5 months, and workers may live from 3-5 years.
- Swarmers are usually produced from mature colonies that have been active for a number of years.
- Research has shown that populations are higher in urban areas than in undeveloped habitats. The termites prefer soil temperatures between 84° and 90° F — never above 104° F.



SOLDIER TERMITE COMPARISON

Drywood Termite (Kalotermitidae)



DRYWOOD TERMITE SWARMER

Approximately 400 global species of drywood termite species are known, but only a few species are important in the United States. Drywood termites live in dry sound wood (usually less than 12% moisture), and derive their moisture requirements from the wood they consume. Infestations can occur in structural timbers in buildings, pieces of furniture, flooring, doors and doorframes, window trim, wooden picture frames, and other isolated pieces of wood. Drywood colonies are relatively small, with a few thousand members lacking the true worker caste, and there are often multiple colonies in the same structure.

Drywood termites do not need a connection to soil and there is no soil in their feeding galleries. They do not build mud tunnels; they construct large, irregular galleries that run across and with the wood grain, with a very smooth, clean, and sandpaper-like appearance. The galleries are connected by openings small enough for one termite to pass through. The sure sign of drywood termite feeding is their fecal pellets that are ejected from the galleries via kick-out holes, often found right below the damaged wood. These pellets are quite unique and are hard, elongated-ovals with rounded ends, and have six concave sides.

Powderpost Termites
Powderpost or "furniture termites" (Cryptotermes spp.) have small fecal pellets and are smaller in size than other drywood termites. Their feeding on furniture or movable wooden objects can reduce wood to a fine powder. They can be found in Florida, southern Louisiana, Texas, Puerto Rico, and Hawaii. Some have been found as far west as Los Angeles and as far north as Ontario, Canada. These creatures are also found in antique furniture.

Drywood termites are hidden insects that are difficult to detect. They live deep inside wood; and except during periods when they swarm or when repair work is being done on infested homes, they are seldom seen.

Colonies are small (usually fewer than 1,000 individuals), can be widely dispersed, and take years to mature. The most common sighting of drywood termites is flying adults (called swarmers) that occur during daytime hours during summer and fall. Dampwood termites also can swarm during summer and fall, but they can be differentiated from the western drywood termite based on their larger size and attraction to lights at dark. In parts of southeastern California another species of drywood termite, Marginitermes hubbardi, and species of desert subterranean termites may also swarm to lights.

While a homeowner may initially detect the presence of drywood termites when they swarm or if fecal pellets are discovered, inspecting and determining the extent of an infestation requires experience and is best done by a professional.

By state law, the minimum requirement for termite inspections includes visual searches of accessible areas. However, detection of difficult-to-find infestations may require removing walls, paneling, and stucco, as well as using ladders and scaffolds.

During a structural inspection for drywood termites, inspectors look for feeding damage, shed wings, fecal pellets, and kick-out holes, i.e. small holes (less than 2mm in diameter) through which termites push fecal pellets out of the wood. Again. These unique fecal pellets have six hexagonal sides and are diagnostic for drywood termites. It is not possible to determine, from fecal pellets alone, whether the infestation is currently active or how extensively the infestation extends throughout the wooden piece or structure.

Dampwood termites also produce fecal pellets that are rounded at both ends (football shaped) and elongated, but they lack the clear longitudinal ridges common to drywood termite pellets. Other structural pests that can be confused through differential diagnosis include wood boring beetles and carpenter ants, see the Wood Boring Beetles of the Home and Carpenter Ants pest section of this course. The final confirmation of drywood termite pellet identification from other wood destroying pests or wood debris may require help from an expert. Cleaning up the fecal pellets around a kick-out hole and checking a few days later to see if new pellets have appeared can help to determine if an infestation is active (as building vibrations and movement may also cause some pellets to appear).

Other detection methods that have been commercialized and tried by the pest control industry include dogs, feeding-sensitive (acoustic emission) devices, fiber-optical devices, movement-sensitive (microwave-based) devices, and odor detectors; but these methods are infrequently used. Visual inspection by inspectors for evidence of termites and damage remain the mainstay of the industry.

Drywood Termite Management

Because of the difficulty in detecting drywood termites and determining the extent of the damage, do-it-yourself treatments are not recommended. In addition, the chemical products needed for controlling these pests are not generally available for homeowner use. Except for wood removal, homeowners should seek help for infestations of drywood termites from pest control professionals.

Existing Infestations
All drywood termite control methods can be categorized as either whole structure or localized. More information, see the section in the rear of course that summarizes the advanced control methods and elimination.

A whole-structure treatment is defined as the simultaneous treatment of all infestations, accessible and inaccessible, in a structure.

Localized or spot treatment is more restrictive and is often applied to a single board or small group of boards. Homeowners should be advised to understand the distinction between whole-structure and localized treatments when deciding which method to select, because all treatment methods are not equal.

Whole-structure treatments have an advantage over localized treatments in that they should eliminate all infestations, even hidden ones. With the uncertainty of current detection methods, particularly when drywall or other wall coverings conceal infestations, there is always some doubt as to the extent of drywood termite colony boundaries and the number of colonies within homes. Consequently, one can never be sure all infestations have been treated when applying localized treatments. The strengths and limitations of whole-structure vs. localized treatments are outlined in the rear section of this course under advanced termite control.

Detecting Drywood Termites
These highly designed creatures nest above ground, away from soil. Since colonies are usually constructed inside wood, finding these termites can be difficult during routine pest and dry-rot inspections. Therefore, one of the best ways to identify an active infestation is the presence of fecal pellets. These pellets are cream to reddish-brown or black. The color of the pellets is not related to the color of the wood. The pellets are about 1-2 mm long and distinctively six-sided, making them easily distinguishable from other wood destroying organisms. Pellets usually fall into piles as the termites push them out of the infested wood.

Fecal Pellet Differences
Drywood termite fecal pellets are kicked out of the colony by workers and may accumulate below infestations. Fecal pellets have a distinct ridged shape and are about 1/25" long (about the size of table salt). Subterranean termites do not kick out dry fecal pellets from their colonies and drywood termite fecal pellets are much larger than the boring dust particles of Powderpost beetles.

Infestation Signs
Signs of infestations by drywood termites and control measures differ drastically from those for subterranean termites.

- Discarded wings accumulating around window sills or in spider webs
- Signs of infestation include:
- Winged insects emerging in evenings and night attracted to lights or TV.
- Wooden pellets (much smaller that rice grains) accumulating on floors or under furniture.
- A sign of advanced infestation is surface blisters. These termites sometimes tunnel close to the surface giving the wood a blistered appearance. Infestations may be

detected by tapping the wood every few inches with the handle of a screwdriver. Damaged wood sounds hollow - a papery rustling sound indicates tunnels just beneath the surface.

• Baiting systems (such as Sentricon, First Line, Exterra) will not protect a structure from drywood termites

• Coastal and southern areas of the state are more likely to have an infestation of drywood termites occur.

• Colonies are smaller and develop over a longer period of time than do subterranean termites therefore the potential for structural damage over a given period of time is less.

• Control methods include whole structure fumigation, spot treatment with insecticides, or spot heat, shock, microwave, and liquid nitrogen treatment. Heat treatments have been used as whole structure treatments.

• Direct treatment of lumber MAY provide protection if the drywood termites must tunnel through the treatment to infest the wood.

• Drywood termites occur in small colonies in isolated wood pieces. Multiple colonies can infest a structure simultaneously

• Drywood termites remain hidden within the wood or other material on which they feed, so they seldom seen. Fecal pellets are ejected periodically, while swarmers fly from colonized wood in late spring and summer.

• Drywood termites will also infest pieces of furniture (particularly antique pieces). Removal of the item and separate treatment of the piece may be all that is necessary in some instances.

• Even though colonies are slow to develop if left unchecked for extended periods of time substantial damage can occur.

• Galleries or tunnels in the wood made by drywood termites cut across the grain of the wood and destroy both soft spring wood and the harder summer growth. Galleries made by the subterranean species follow the grain of the wood and the soft spring wood is attacked first.

• In some cases, treatment of an infestation of drywood termites may not be needed if the area of infestation can be identified and physically removed (this may or may not be practical from a structural standpoint).

• Late Spring and Summer months are the peak season for winged drywood termite swarming flights.

• Swarming (mating flights) often occur in the evening hours.

• Termite protection contracts are usually for ONE type termite only. A SEPARATE contract is usually required for treatment and protection from subterranean termites and drywood termites.

• Treatment of the soil under and around the structure will not protect a structure from drywood termites

• Winged termites can be distinguished from winged ants because termites have a thick waist, straight antennae, and equal-length wings whereas ants have a distinctly thin or wasp-like waist, elbowed antennae, and shorter hind wings than fore wings.

Summary

Drywood termites are important structural pests in tropical and warm/dry climates. Unlike most other termites, drywood termites do not need contact with soil moisture. Control of "drywoods" can be more difficult because their colonies are not confined to the soil.

Pacific Dampwood Termite *Zootermopsis angusticollis*

The Pacific dampwood termite is the largest and the most significant dampwood termite in the United States. This species ranges from Baja California and Mexico to British Columbia. They have been found up to 6,000 feet above sea level, but more commonly in the cool and humid coastal areas. These termites get their name from the need for a high moisture content in the wood. They are extremely common in wooded or forest environments in cooler climates. Colonies are generally small by termite standards, with several thousand workers in a mature colony. There is no true worker caste, as nymphs perform the duties of the colony and all nymphs become either adult soldiers or adult alates.

PACIFIC DAMPWOOD TERMITE REPRODUCTIVE

Alates swarm after sundown on warm summer evenings. The reproductives may attack wood without soil contact. Damage is indicated by large galleries that usually follow the direction of the grain, and with fecal pellets packed into some of these galleries. The texture of the sides of the galleries is “velvety”, or slightly rough textured.

PDWT SOLIDERS

Identification of Swarmers and Soldiers
Swarming may occur throughout the year, but most often from August through October. Swarming usually will occur on warm humid evenings just before sunset. The reproductives are strongly attracted to light. Swarmers are up to 1" in length and are light to medium brown with dark brown wings.

The Pacific dampwood termite colony consists of three castes: reproductives, soldiers and nymphs. Winged reproductive, or alates, are almost one-inch long and their color ranges from yellowish-brown to cinnamon-brown. Soldiers display flattened heads with brown or yellowish-brown coloration, while their jaws are black or dark brown. Nymphs are cream colored. Pacific dampwood termites are also known as “rottenwood termites” due to their preference for very moist wood. (Other species of dampwood termites are also called “rottenwood termites”.

Soldiers have a large head armed with long black toothed mandibles. The anterior portion is black generally shading to a dark reddish-brown in the posterior position. The abdomen and thorax are a light caramel color, the abdomen varying according to the stomach contents at the time. The largest termites in the United States, soldiers may be very large, reaching 5/8 to 3/4".

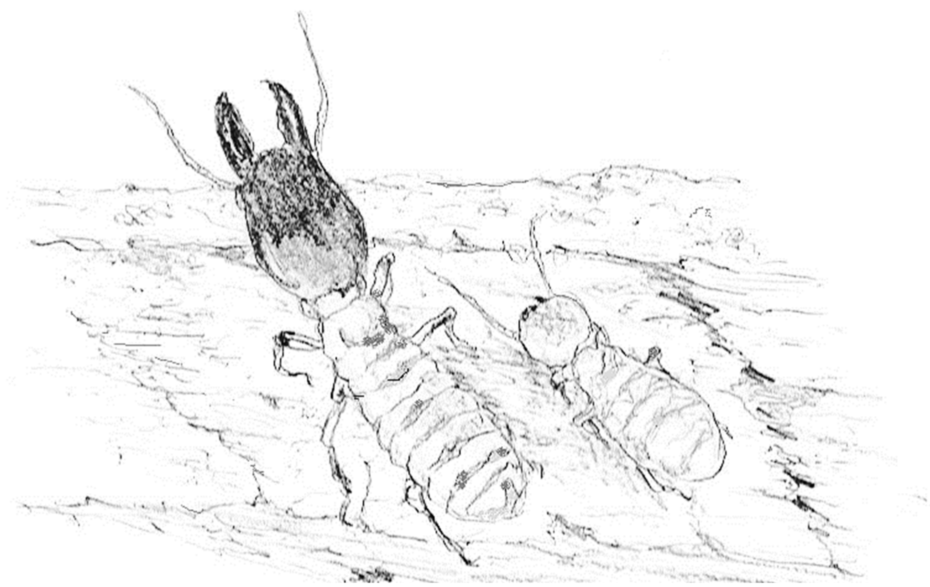
Identification of Timber Damage
The tunnels vary greatly in size and shape and in sound timber may favor the softer springwood. Fecal pellets are found throughout the tunnels, and are hard small, oval and about 1/25“long. The color of the pellets may vary according to the type of wood being consumed.

Pacific Dampwood Termite Biology and Habits
This species will attack wood of all types throughout its range. Timbers in contact with the soil or structures built near or over water are common targets. This species is known to be very tolerant of moist conditions, even being found in pilings subject to tidal flooding. Colony size varies but may contain as many as 4,000 individuals.

Colony growth is aided by the production of secondary reproductives. Like other termites this species aid in the spreading of wood decay fungi, the spores of which are carried in the gut and on their bodies. A well-established colony will produce winged reproductives which may infest nearby timber.

Summary
The life history of the Pacific dampwood can be summarized as follows. Both male and female swarmers excavate a chamber, they enter, and the chamber is sealed. They mate and within about 2 weeks, eggs are laid and the colony is founded. The queen lays about 12 eggs. The second batch is laid the next spring.

Swarms tend to occur on warm, humid evenings during the late summer or early fall, often appearing after early rains. These swarms are smaller than those of other termite species, as Pacific dampwood termite colonies only foster up to about 4,000 members. After mating, male and female alate pairs usually begin the new colony in sound wood such as recently cut logs and the living parts of otherwise dead trees.



DAMPWOOD SOLDIER (L) NEXT TO WORKER TERMITE

Comparison of Dampwood Termites

Pacific Dampwood Termite

The Pacific dampwood termite colony consists of three castes: reproductives, soldiers and nymphs. Winged reproductive, or alates, are almost one-inch long and their color ranges from yellowish-brown to cinnamon-brown. Soldiers display flattened heads with brown or yellowish-brown coloration, while their jaws are black or dark brown. Nymphs are cream colored. Pacific dampwood termites are also known as rottenwood termites due to their preference for very moist wood.

Desert Dampwood Termite

The swarmers, or winged reproductives, kings and queens of this species are dark brown; soldiers are brown or yellowish in color; and nymphs have spotted abdomens. Probably the best way to determine the presence of these termites, as well as other species of dampwood termites, is the appearance of the infested wood. Tunnels that have very smooth walls – looking almost like they have been smoothed out by a woodworker using sandpaper, connect chambers within the infested wood.

Nevada Dampwood Termite

Nevada dampwood termites have three primary castes: nymphs, reproductives and soldiers. The reproductive, also known as alates, are often up to ¾-inches long and have dark-brown wings and dark-brown bodies. Nymphs are cream colored and soldiers have brownish-colored heads with very large mouthparts that are used to help defend the colony from predators.

Desert Dampwood Termite *Paraneotermes simplicicornis*

Desert Dampwood Termites are found in Arizona, New Mexico, Texas, and Southern California. Living where the habitat is dry and arid in these regions of the United States. They ingest damp wood that is buried in the ground. Munching termites attack tree roots, bushes, door frames and fence posts. The Dampwood also feeds on live trees – wood that is under ground level.

DAMPWOOD TERMITE SOLIDER

Dampwood termites are almost an inch long, which is quite a bit larger than the Subterranean or the Drywood variety. Swarming occurs between January and October – which is a long swarming season. These insects only infest wood and timber that contains high water content. The 'Dampwoods' come in a variety, and each is named for the location in which they are found: Desert Dampwood Termites, Florida Dampwood Termites, Nevada Dampwood Termites, and Pacific Dampwood termites.

Identification of Swarmers and Soldiers
The swarmers of this species are dark brown, swarming during the daytime. This species prefers the arid and semi-arid regions of the southwest, from Texas through California and Mexico. A prevalent pest for gardeners, these termites are known for destroying vegetation, notably citrus. These pests also prefer to attack timber and other wood high in moisture. Desert Dampwood termites are also notorious for emitting a strong odor, and unlike other termites does not create mud tubes. They can be found residing in dampened wooden areas, and are not likely to burrow in soil.

Identification of Timber Damage
This species infests wood at or below ground level in the southwestern United States. It sometimes girdles young citrus trees and grapevines below the soil line in desert areas. In the southwest it attacks living trees and bushes and is a problem for citrus groves. It is a pest of timbers in service, infesting moist timbers that are in contact with soil. Untreated posts, poles, and fences are attacked below ground level.

Desert Dampwood Termite Biology and Habits
This species does not build mud shelter tubes above the ground in order to reach wood. This is an unusual dampwood termite in several respects. The colonies extend from the wood into the soil, they sometimes kill living shrubs and trees, frass is cone-shaped rather than cylindrical, and the termites have a pungent odor. They also have directed trail-following behavior, unlike other dampwood termites.

The nymphs are the caretakers of the colony and feed the kings, queens and the soldiers. This desert termite prefers to eat damp wood that is below ground, but will also consume shrub or tree roots, fence posts and doorframes. Desert dampwood termites also damage living trees by feeding on and girdling them below the ground surface.

Paraneotermes simplicicornis causes significantly less economic damage than subterranean termites and other dampwood termite species. Desert dampwood termites seldom infest homes, but when they do, they are likely to be found in wet wood that is kept damp by water leaks or excessive moisture from standing water. Therefore, the presence of this termite often indicates moisture and wood decay within the home. For this reason, it is very important to make sure that gutters and downspouts work properly to drain rainwater away from the house.

This desert species **rarely damage homes** like others of their kind. The desert dampwood termite is **not classified as a major** structural pest in the United States.

When found in a home they are usually found in wet wood or wood that is kept wet by constantly dripping water. Occasional infestations of dwellings are commonly found in door frames or baseboards.

The desert dampwood termite is the only dampwood termite considered a pest of wooden structures in Arizona.

The swarmers, kings, and queens of the Desert Dampwood Termite species are brown. They have brown bodies and brown wings.

Soldiers are yellowish brown, and nymphs are a creamy color with a spot on their abdomen. This spot indicates the presence of food.

Nevada Dampwood Termite *Zootermopsis nevadensis*

Nevada Dampwood Termites are found primarily in Nevada, Idaho, California, Washington, and Oregon. This termite dwells in mountain regions and likes the high altitude and dry climate. This termite is attracted to wooden structures that are in contact with soil and built over or near water.

Even though their preference is a dryer climate, moist conditions are tolerated. This muncher also assists in the spreading of wood decaying fungi by carrying its spores on their bodies and in their stomachs. Soil contact is not necessary but will nest in fallen wood that has been buried.

Nevada Dampwood Termites do not like highly populated areas. But when these critters do infest a home they usually attack wood siding, fence posts, pilings, pond bridges, and downspouts.

Nevada Dampwood Termite swarmers are dark brown with wings, growing up to 3/4″ long. The soldier termites have long flat heads with straight sides.

Workers have large abdomens and are light brown. Nymphs are a creamy color with a spot on their stomachs (digesting food).

Occasionally termite control experts will find a home infestation. It usually occurs in the wood siding of a home where the siding touches the ground, around downspouts, and in fence posts. They will not normally attack homes because the moisture content is too low.

Swarming

The Nevada Dampwood Termite swarms in the spring, summer and early fall. When swarming, they seek out wood with a high moisture content to start new colonies. The most obvious sign of infestation is discarded wings and alates found in your home or around your property.

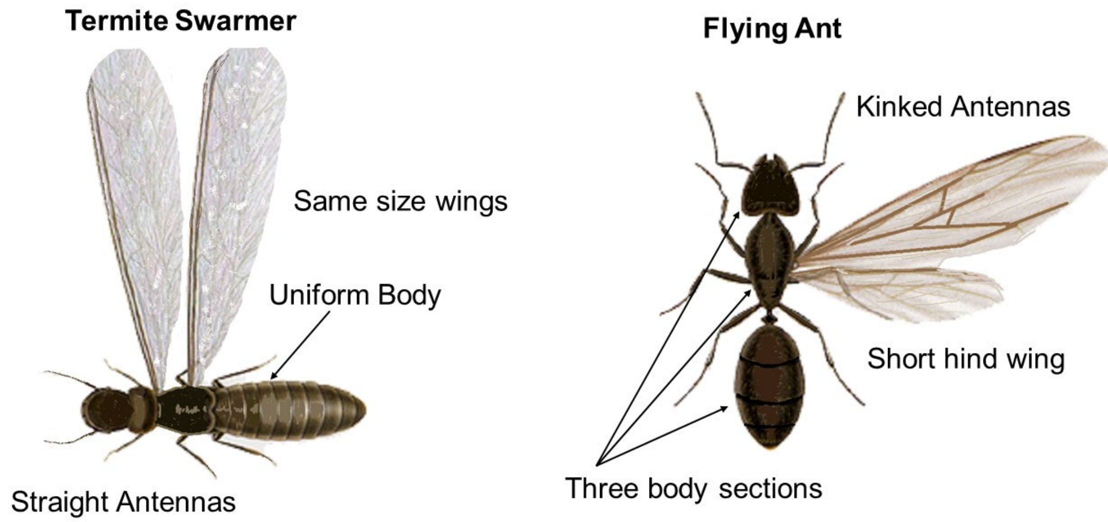
Upon inspection of your home, if you find an infestation you can do certain things that will discourage their occupation.

- Remove wood piles that are around your home
- Replace infested wood with pressure treated timber
- Fix any leaks around your home

Summary

Nevada dampwood termites have three primary castes: nymphs, reproductives and soldiers. The reproductive, also known as alates, are often up to ¾-inches long and have dark-brown wings and dark-brown bodies.

Nymphs are cream colored and soldiers have brownish-colored heads with very large mouthparts that are used to help defend the colony from predators.



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SWARMER TERMITE & FLYING ANT

Desert Dampwood Description

- Soldiers are up to 5/16" long with flat heads and short wide black mandibles. Desert Dampwood Termite soldiers also have an antenna on either side of their head.
- Nymphs take care of the colony and feed the others. This muncher's favorite food is damp wood even though they like dryer weather climates. If trees around your home show signs of infestation, you may need to take them down. Weak wood trees are a hazard to the home.
- The winged adults swarm starting in May until September – in the daytime. Termites swarm, mate and start a new colony. The desert dampwood prefers citrus trees and can use the sap for required moisture.
- This termite has a strong odor.
- This species does not build mud tubes to stay hydrated or to reach a wood source. The colony itself will stretch out over a distance to go from wood to soil. This distinction makes the Desert Dampwood Termite different from others of its kind.
- The desert termite lives in small colonies – less than 1500 termites. If infected wood is found – look closely for tunnels inside the wood, the tunnels will appear smooth as is sanded.

Formosan Subterranean Termites

Introduction
The Formosan subterranean termite, Coptotermes formosanus (Shiraki), was first described as a species in 1909 from specimens collected on the Asian island of Formosa. It is now generally accepted that the termite is native to China and Formosa. This termite is considered a serious structural pest whenever it occurs.

The Formosan subterranean termite has been found in Japan, Sri Lanka, Philippines, Guam, Hawaii, South Africa and the continental United States. Although officially reported in Hawaii in 1913, newspaper reports indicate that the termite was on the island as early as 1869.

FORMOSAN SUB TERMITES- SOLIDERS AND WOKERS
NOTICE THE BEADED ANTENNA

The first report of the Formosan termite in the continental U.S. was from a Houston shipyard in 1965. It was reported in Louisiana in 1966 and Charleston, S.C. in 1967, although specimens collected in Charleston in 1957 indicate that the termite was introduced nearly ten years earlier. The Formosan termite has also been identified in Broward and Dade counties in Florida (1980-3); Mobile, Lee, and Baldwin counties in Alabama (1985-87); Memphis, TN (1985); North Carolina (1990); San Diego, CA (1991); and Atlanta, GA (1993). It is believed that these infestations were transported in infested building or plant materials from areas where the termites were well established.

Biology
As with the native subterranean termites, Formosan termites initiate new colonies by sending out winged reproductives (alates) from established colonies. The Formosan swarms occur from May to July depending on the area that receives constant humidity and warmth. Formosan termite swarms occur from dusk to midnight and the alates are attracted to lights. After a short flight (usually not more than 20-50 yards) the alates lose their wings, pair off, and seek a small crevice in moist wood to begin the new colony.

It takes 3-5 years for a mature colony to develop from a queen, which lays approximately 2,000 eggs/day. Mature colonies can have a population of 10 million foraging workers, soldiers, a primary queen, and several secondary reproductives. The foraging territory of a mature colony can occupy several thousand square feet.

Destructiveness
The Formosan termite is known to attack over 50 species of living plants as well as structural lumber. A survey in New Orleans showed that 10% of the utility poles in the city are infested with the Formosan termite. This termite is often described as aggressive in both its feeding habits and foraging tenacity.

FORMOSOAN MUD TUB AND DAMAGE EXAMPLE

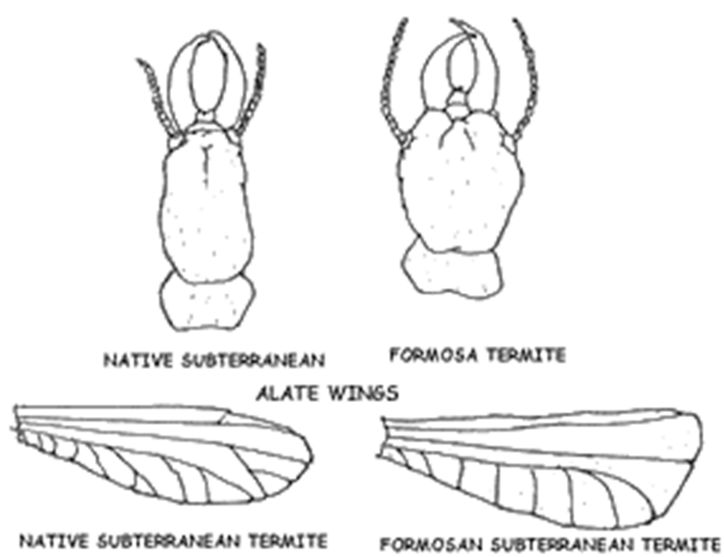
Recognition

Damage
The damage caused by the Formosan termite is similar in many respects to the damage done by native subterranean termites. Termite feeding will follow the grain in a piece of structural lumber, but the Formosan termite is more likely to feed on both the summer and spring wood, leaving a larger hollow space in the damaged lumber. Native subterranean termites usually fill their feeding galleries with soil and excrement; whereas the galleries of the Formosan termite are cleaner--practically soil free and covered with whitish spots.

In severe infestations, Formosan termites will fill hollow spaces, or even wall voids, with a combination of termite excrement, macerated wood, saliva and soil. This material, called carton, can be used by the Formosan termite to form nest-like structures and is unique to the Formosan termites. Carton nests are constructed in or near the feeding site and a single colony may have several of these auxiliary nests – each containing secondary reproductives.

Super Destroyers
They cannot eat through concrete but have been known to attack non-cellulose materials like plastic, asphalt, and thin sheets of soft metal. Although laboratory studies indicate that the individual Formosan termite eats slightly more wood than the native subterranean termites the larger colony populations found with this termite can cause severe structural damage to unprotected homes in 2 years. The Formosan subterranean termite usually enters structures from colonies maintaining contact with ground to provide the necessary moisture requirements. However, the Formosan termite, more than the native subterranean species, is able to initiate colonies which have no ground contact (aerial colonies).

Insect Identification
Three caste forms of subterranean termites are often found at the site of an infestation--alates, soldiers and workers. Only the alates and soldiers can be used for identification.



SOLDIER TERMITE COMPARISON

Alates - Below is listed a comparison of Formosan alates and the three common native subterranean species.

	Formosan	R. flavipes	R. virginicus	R. hageni
Body Size	12-15 mm (0.5 – 0.6 in.)	8-10 mm (0.3 – 0.4 in)	4.5-5 mm (0.1 – 0.2 in)	4.5-5 mm (0.1 – 0.2 in)
Body Color	Light yellow-brown	Black	Black	Light yellow-brown
Wings	Covered with fine hairs	No hairs	No hairs	No hairs
Wing size	> 11 mm (0.4 in)	8-9 mm (0.3 in)	6.5-7.5 mm (0.25 in)	6-7 mm (0.2 in)
Flight times	May – July Night	Feb – April Day	May-June Day	August Day
Antennal Segments	Greater than 20	Less than 20	Less Than 20	Less than 20

Soldiers
Soldiers of the Formosan termite have an oval-shaped head compared to the oblong shape of the native subterranean soldiers. In addition, the Formosan soldiers have a well-developed fontanelle which forms a tube-like structure on the front margin of the head just above the mandibles. When disturbed, the soldiers emit a milky white fluid from this opening; whereas native termite soldiers do not eject any noticeable substance. The proportion of soldiers to workers in native subterranean termite colonies is approximately 1-2 to 100 (1-2%), in contrast to the Formosan termite colony which contains 10-20 soldiers for every 100 workers (10-20%).

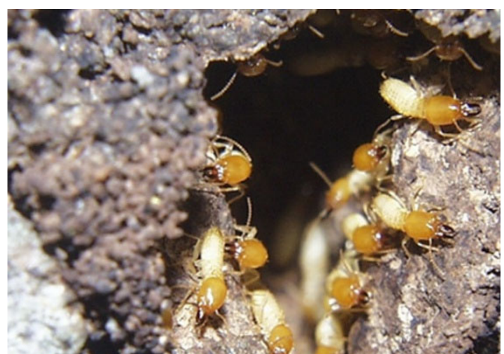
Subterranean Termites Damage Compared to Formosan
Subterranean termites most commonly live in the soil where they can avoid temperature extremes and obtain the moisture essential to their existence. Rather than building a discreet nest like their tropical cousins, subterranean termites construct numerous scattered nursery areas where reproductives are found together with piles of eggs and young termites. These nursery areas can be in buried stumps, logs, dead roots or pieces of lumber left in the backfill after building construction. Nursery areas can also be found in the wood of structures. These areas can be as far down as 3 to 6 m below ground level.

Because subterranean termites can get moisture from the soil, they can attack any dry wood or other source of cellulose within foraging distance of the colony. Besides wood structures, subterranean termites will attack untreated fence posts and attached boards, utility poles, and any other food sources such as cardboard, paper, or fiberboard in, on, or close to the ground.

They prefer to feed on the softer spring growth of infested wood, leaving the harder summer wood and a paper-thin outer shell of wood. Termite nursery areas located under sub-floors or concrete slabs near furnaces, water heaters or other sources of heat can remain active during the winter. Where a wood source is not in contact with the soil, workers will build earthen '*shelter tubes*' over concrete foundation walls or in cracks in the concrete through which they can travel to and from the food source and soil moisture.

Occasionally, the tubes can be built downward from a wood member to the ground. The tubes provide protection from predators, especially ants, which are mortal enemies of termites.

Besides gaining entry via wood touching or close to the ground, termites can enter through cracks in concrete foundations and slabs, and through spaces around utility pipes cut through cement foundations. Workers have been observed following the roots of spreading junipers under landscape cloth covered with bark mulch or wood chips. This environment also provides protection from ants and high temperatures. Workers will also feed on wood chips in contact with soil.



The Formosan Infestation Map is a made possible through the cooperation of PCOs, state associations, state regulatory officials and termite researchers. It is continuously updated, so please return to the LIPCA web site often.

Assessing 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.

When inspecting for termites, it is useful to probe wood with a knife or flat blade screwdriver to detect areas that have been hollowed. Severely damaged wood may have a hollow sound when it is tapped.

Again, Subterranean termites do not reduce wood to a powdery mass, and they do not create wood particles or pellets, as do many other wood-boring insects.

Mass Emergence
The mass emergence of winged termites in the spring is often the first sign of an infestation. In the majority of cases, they emerge in homes near sources of heat - furnaces or water heaters. The appearance of winged termites means that the infestation has been around for at least 3 or 4 years. Therefore it is likely some damage has already been done, so it is important to find where the termites have been feeding, how much damage has been done, and how much repair is needed.

A qualified professional termite control service should be hired to apply an appropriate termiticide to protect the building from further damage. Other means of detecting infestations include knocking on walls, floors, sub-floor wood, joists, etc. and listening for the tapping of soldiers, and looking for shelter tubes on the outside of the building and under the sub-floor.

Because subterranean termites have a constant demand for water, one should closely examine areas near moist soil, such as below dripping outside faucets, leaking underground sprinkler pipes and nozzles, and below downspouts.

Where damage or termites are suspected, prod with a sharp narrow implement to check the soundness of the supporting wood structure. The detection of termite infestations is best left to professionals who have the experience to do it thoroughly and accurately. Termites can enter a building from one or more points so it is important to locate all points of entry for control purposes.

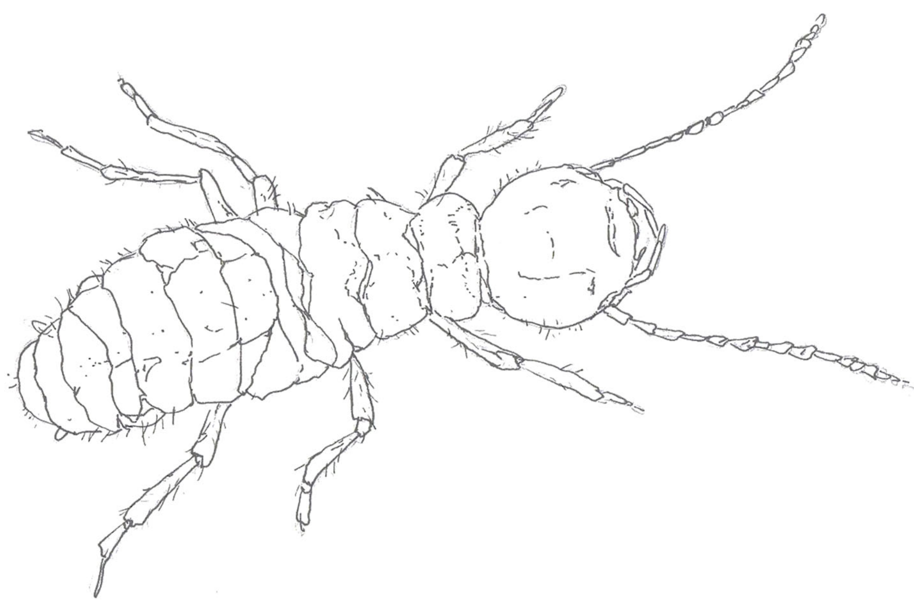
Outdoors, termites can be detected by driving wooden stakes into the ground at varying distances from buildings and other wooden structures. Examine the stakes every 3 months for termites or signs of their feeding damage.

Evidence of Termite Infestations

1. Wood damaged by subterranean termites can be readily penetrated with a screwdriver, ice pick, or knife. The wood easily breaks apart, revealing mud tubes attached to wood galleries or tunnels in an irregular pattern. The tunnels may contain broken mud particles with fecal materials. In the case of an active colony, white termites may be found in infested wood.

2. The presence of winged males, females, or their shed wings, particularly when the adults fly inside the building, indicates an infestation in the building.

3. Another indication is the presence of mud or shelter tubes extending from the ground to woodwork or on foundation walls. Workers travel periodically via shelter tubes to their colony to obtain moisture and perform feeding duties. Workers build mud or shelter tubes from soil and wood particles, and coat them with a glue-like substance that they secrete. Each mud tube is about the diameter of a lead pencil.



SUBTERRANEAN FORMOSAN TERMITE

How Old is the Damage?

Based on normal feeding activity, it takes 3 to 8 years to cause appreciable damage to a structure. There have been some predictions that, under ideal conditions, a termite colony of 60,000 workers may consume a one-foot length of 2" x 4" pine in 118 to 157 days. In the United States, the extent of damage may be less because of a reduction in feeding activity during the cold season.

Termites in Palm Trees

Termites eat palm trees because they contain high cellulose concentration and fiber. When termites attack a palm tree, they will start eating it from the bottom where the roots are attached to the ground. They will live inside the tree and eat it for quite some time and you will only notice the damage after it is severe.

Subterranean termites will build **the mud tube on the trunk**

A sign of termites in a palm tree, includes a thin wall of soil or mud tubes, a mound near the base of the tree, but not always, depending on the soil and tree's location to concrete or street. You will also notice frass or termite waste that looks like dust around the palm tree. The frass will be in large amounts because there will be plenty of food for the termites to feed on. The palm tree will eventually fall down because termites will also have eaten its root and nothing can save the tree at this point.

Treatment Options

The methods of termite treatment inside a living tree are pretty much the same as the ones for the infested house or timber.

So, here's what you can do:

- **termiticide barrier**;

- **foam or liquid termiticide injection**;
- **baiting**.

The most popular method of getting rid of the termites in a living tree is **to treat the soil around the infected tree**, to form a protective barrier.

Termidor or Premise Treatments
Some of the termiticide, that can be used for this treatment just repel the insects, and are more of a preventive measure, while the others, such as Termidor or Premise, have no smell or taste, so they do not keep termites away. Instead, they have the poison of the delayed action, that the foraging workers bring inside the nest, after passing through the treated soil, and it kills the whole colony in a matter of days.

You'll need to dig a trench around the tree base in 3-foot radius and pour the insecticide in the solution needed into it. Usually, the strong termiticides, that has Fipronil or other hazardous chemical as the active ingredient should be used

Sometimes the healing of the tree requires wrapping it in special material that keeps the insects and fungi away and gives the palm some time to recover. It is best to call an arborist to save the tree.

Cutting Down a Tree with Termites
Often by the time a pesticide applicator is called, the damage is too great. The only thing to do is spray the tree and hope for the best, but many times, the tree needs to be cut down and disposed of. Before you cut down a termite infested tree, you need to inspect if the damage has been spread to those that are around it. If the area is clear, spray a termite resistant i.e. liquid termiticide to the rest.

Spraying a liquid termiticide will prevent termites from infesting other live trees that are growing around the infested one. The importance of spraying is that, when you cut down a termite-infested tree, it will fall down and crack because it is hollow and dry. Termites will then scatter all over the place and they will look for a new habitat.

Termites will crawl the other trees that are near to build and start a new colony. This is why you should take preventive measures to ensure that when the tree is cut, termites will not infest the other trees around. Those small pests are very organized and starting a colony is very easy for them.

If you are cutting down a tree with termites near the house, ensure you do so during the day. Use a rope to ensure that the tree falls away from the house. As you cut, use the rope to pull the tree so that when it falls, any scattered termites will not go into the house.

Tree limbs and leaves that touch the roof can attract termites to your home. These branches give termites a pathway from the ground to your house. Regular tree trimming can **dissuade termites from migrating to your roof**. Similar to tree limbs, mulch can draw termites closer to your home.

Signs of Termites in a Live Tree

Termites **rarely feed on live trees**, so if a tree is infested then it probably has a significant amount of dead or dry wood. This is common during a drought. If the tree is not sick or dry, then the culprits are likely Subterranean, Formosan or depending on your area, climate, drought, Dampwood termites which feed on certain species of live tree.

Live Trees that Termites will eat Depending on moisture	**Trees that Termites don't eat or don't perfer**
1. Oak trees, Red and White	1. Iroko tree
2. Deciduous trees - Ash, Alder, Maple, etc.	2. Greenheart
3. Conifers, Pine trees	3. Most Cypress trees
4. Black locust or the False acacia	4. Teak tree
5. Siberian pea tree	5. Some Cedars, some Redwoods
6. Gum trees	6. Niove tree
7. Osage-orange – Fruit Trees	7. Mahogany
8. Palm Trees	8. Black Walnut, Black cherry, Chestnut, Honey mesquite

- All depends upon the following conditions: weather, tree's health and tree's moisture. Termites will eat most redwoods but there are species that termites will avoid. Technically, redwood and many cedars are edible.

To identify and know if a live tree is being eaten by termites, you will check for their activities on the trunk and the roots. This is important because you can save a tree with termites if the signs are identified early enough.
Termites have different behaviors depending on the type and group. For example, the Formosan and the Drywood termites will eat a tree from inside while the Subterranean will feed on the trunk from outside. Here are some basic signs that will help you identify a termite infested tree:

1. Mud Tunnels on the Trunk
Mud tunnels on the tree trunk that look like tubes is a sign of subterranean termites on a tree. Those tunnels begin from the tree roots as they climb upwards. Those are made to protect them from the sun and anything that may attack them as they feed on the tree. They walk through those tunnels as they crawl on the tree. If you break those tunnels open, they will fall out in a rush towards cover because those termites do not like direct sunlight that dehydrates them. This is their natural way of survival. Those

2. Termite Holes in Trees
A sudden appearance of tiny holes on the tree's trunk with mud around it is a sign of termites' infestation in a tree. If the drunk is too dry, the holes may continue to grow. In some cases, there may be liquid-like sap or fluids oozing from the trunk through the holes. The liquid from termite holes on a tree trunk may be fresh or dried depending on how long the tree has been injured. If most of the liquid is fresh, then the infestation is at its early stages. If it is dried on the trunk, then this is a sign of a termite infestation on the tree that has lasted for a long time.

3. Termite Waste
Termite poop which is also known as frass can be found around an infested tree and this is a sign that termites are eating into the tree. To identify termite poop, look for tiny particles that look like powder with a color shade that is similar to the tree. If the tree is dark brown, the termite poop will also take the same color.

When this is found in plenty, it an indicating that the attack is serious. The tree trunk in also be covered by termite waste and this should be easy to identify. In most cases, the powdered termite poop will be spread around the tree. It is easy to notice them since they will be spread on the grass or the leaves of any plants growing around the tree.

4. Missing Bark
Missing bark is a telltale sign that a tree is infested with termites. Trees can lose bark for a variety of reasons, including disease and physical injury. But if you see large sections of missing bark, it could indicate a termite infestation. When termites infest a tree, they'll begin to devour it from the inside. Over time, the tree's structural integrity will become compromised, resulting in the loss of bark.

5. Termite Wings
Of course, termite wings are a characteristic sign that a tree is infested with termites. Subterranean termites, specifically, have wings that they'll drop after finding a suitable food source. Most termites drop their wings inside their food source, though you may find them outside of an infested tree as well.

6. Discolored Leaves
When termites are eating a live tree, they will soon derail and rob it of its natural nutrients. This will cause the tree to have discolored leaves. In most cases, some branches will start to fall off. If they break open, you will see termites and their eggs in it. Discolored leaves with dry branches is a sign that the termites have already eaten and damaged the tree. Severe cases like that cannot be reversed and it is better to bring the whole tree down. This will prevent further damage to other trees around that area.

Termite Inspection Procedures Sub-Section

Applicators may be able to locate termite damage by probing wood with a screwdriver, ice pick, or knife. Start in the basement and use a bright flashlight. Look for mud tubes and the presence of swarmers. Termite damage/activity is often found during building remodeling or repair. Some agencies such as Farmers Home Administration (FHA), Veterans Administration (VA), Housing and Urban Development (HUD), and loan companies require termite inspections during real estate transfers. If necessary, seek help from professional pest control operators or experienced entomologists.

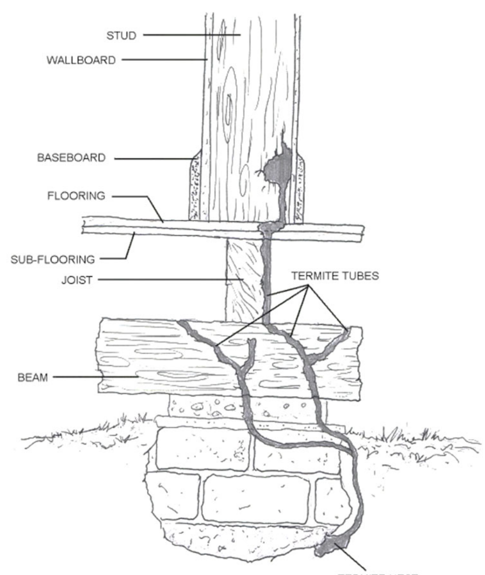
You as professional pesticide applicator, should inspect exterior and interior foundation surfaces, particularly construction where wood is on or near the soil.

Mud tubes are solid evidence of termite activity. Other inspection sites are:

1. Wood construction in basement and crawl space (if present).
2. Sills, joists, support posts, basement window frames, wood under porches.
3. Hollow blocks, cracks in concrete or brick construction and expansion joints.
4. Scrap wood on ground, old tree stumps, fence posts, and exterior frames of basement windows.

Useful Information If Treatment is Necessary

If termite activity is suspected or found and an insecticide treatment is necessary, it is important to outline the plan of the building, indicating sites of termite activity and treatment procedures. Building owners/managers will require inspection reports and cost estimates. Always provide information about your chemical treatment procedures, repair of woodwork, warranties, copies of the insecticide label, and other pertinent information. Provide proof of liability insurance.



Control Objectives

The goal is to establish a continuous insecticide barrier between the termite colony (usually in the ground) and the wood in a building. Sometimes a secondary termite colony may exist above ground (in roof or other areas with a constant moisture supply) which requires additional treatment.

General Treatment Guidelines

Insecticide barriers are generally established during:

1. Pre-construction (during construction).
2. Post-construction (existing building). In an existing building, termite treatments may involve any of the

following: a) mechanical alterations, and b) use of an insecticide for treating the soil, foundation, and wood.

In most cases, an untrained homeowner or building manager should not attempt a termite treatment.

Generally, termite treatments should be performed by professional pest control operators (PCOs), however, most termite chemicals or products are easily obtainable on Amazon or the Internet, thus providing access to chemicals to the public or handymen.

Termite ground or slab treatment requires special tools such as hammer drills, sub-slab injectors, rodding devices, high pressure pumps, a power supply, protective equipment. Several insecticides are registered in United States for termite control (Table 1). All of these insecticides control termites if properly applied. We will carefully study ground treatment in this course.

The procedures described here are general guidelines, and the applicator must follow the insecticide label directions for dilution, application rate, and other relevant information.

Caution

1. Do not apply insecticides when soil is frozen or water-soaked (saturated). Frozen or saturated soil will not permit adequate absorption for even distribution of insecticide.
2. Do not permit humans and pets to contact treated surfaces until dry.
3. Before using insecticides for termite control, always read, understand and follow all label directions.
4. Keep all pesticides in original containers, out of reach of children and do not contaminate food, feed and water.
5. Do not plant garden food crops in treated soil.
6. Do not allow children and pets to play in treated soil.

Pre-Construction Treatment

Horizontal Barriers: In general, treat the footing trench with insecticide before pouring cement footings. After grading is completed, apply diluted insecticide to areas before pouring slab floors, slab-supported porches, patios, carports, and entrance platforms at the rate of 1 gallon per 10 square feet.

Vertical Barriers: Establish a chemical barrier in areas such as around the bases of foundations, plumbing, utility entrances, and backfilled soil against foundation walls. Treat crawl space areas either by rodding or trenching procedures. To produce a vertical barrier in soil, apply insecticide at the rate of 4 gallons per 10 linear feet per foot of depth. After treatment, cover the crawl space area with a layer of untreated soil or polyethylene sheeting.

Post-Construction Treatment

Do not apply insecticides until locations of radiant heat pipes, water pipes, sewer lines, and electrical conduits are identified.

Buildings requiring treatment generally fall into three categories:

a) building on slab construction,
b) building with crawl space, and
c) building with a basement.

There is a common belief that termites cannot penetrate slab foundations. Termites cannot penetrate solid concrete but they can enter through cracks as small as 1/64 of an inch.

Building on Slab
Controlling termite infestation in a building on a slab is especially difficult and hazardous. In this type of construction, heat ducts (pipes) are buried in the concrete and serious damage can occur when they are accidentally drilled for holes to inject insecticide solutions. Drilling through electrical conduits or plumbing imbedded in the floor is another problem.

Treat the exterior of the foundation by digging a narrow and shallow trench about 6 inches wide along the outside of the foundation.

Apply the diluted insecticide to the trench and soil at the rate of 4 gallons per 10 linear feet. Cover treated soil in the trench with a thin layer of untreated soil. For an inside barrier, drill slab and space holes about 1 foot apart and 6 inches from the wall.

SUB-SLAB INJECTOR

Using a subslab injector, inject insecticide through holes at the rate of 4 gallons per 10 linear feet. After application, plug all holes with mortar or any other special compound.

Table 1. Insecticides commonly used for subterranean termite control (check with your State for restrictions)

Brand or trade names	Generic or common names	Dilution rates	Manufacturers
Available to professional pest control companies			
Demon TC	cypermethrin	0.25%	ICI Chemical Co.
Dragnet FT	permethrin	0.5-1%	FMC Chemical Co.
Dursban TC	chlorpyrifos	0.5-1%	Dow-Elanco Co.
Equity	chlorpyrifos	0.5-1%	Dow-Elanco Co.
Ficam[a]	bendiocarb	0.25%	Nor-Am Chem. Co.
Prevail FT[b]	cypermethrin	0.3-0.6%	FMC Chemical Co.
Pyrfon 6	isofenphos	0.75%	Mobay Chemical Co.
Torpedo	permethrin	0.5-1%	ICI Chemical Co.
Tribute	fenvalerate	0.5-1%	Roussel Bio Corp.
Available to general public			
Orthoklor Soil Insect & Termite Killer	chlorpyrifos	0.5%	Chevron Chem. Co.
Black Leaf Termite Killer	chlorpyrifos	0.5%	Black Leaf Products
Chlor-Guard Termite Preventor	chlorpyrifos	0.5%	Security Products

[a]Registered for spot treatment only
[b]Registered for pre-construction treatment only

We will go more into detail in the Advance Treatment Section.

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

Termite Management Sub-Section

You will learn the fundamentals of termite and related wood destroyer management and control techniques. At the end of this section, you will be able to understand and describe pest management, control and elimination techniques of wood destroyers. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Conventional Pest Control Verses Integrated Pest Management

"Conventional" Pest Control

1. Chemical intensive
2. Emphasis on Killing pest directly
3. Largely reactive to pest outbreaks
4. Primary purpose of site visits is to apply more pesticide
5. General and overuse of pesticides
6. Less emphasis on prevention

Integrated Pest Management

1. Knowledge intensive
2. Emphasizes modification of conditions that favor pests
3. Systematic program of long-term pest control
4. Major purpose of most site visits is to inspect and monitor
5. Pesticide use is limited in terms of types, amounts and locations
6. Major emphasis on prevention of pest problems

Types of Pesticide Spectrums

Broad-Spectrum

A pesticide that is effective against many pest. An example of a broad-spectrum pesticide is methyl bromide, which is designed to control pests ranging from small insects and pathogens to larger weeds and rodents. The pesticide can be injected into the ground to kill organisms in the soil that might harm the plant while it is growing. It can also be pumped into warehouses or barns to kill pests that could harm the plant during storage or transport for sale.

Narrow-Spectrum AKA Target-Spectrum

Developed to kill specific organism types. An example of a narrow-spectrum pesticide is chitin inhibitors, which are chemicals that interact with chitin, a component of the exoskeleton of insects. This pesticide inhibits the development of chitin and will eventually result in the death of the insect. The chitin inhibiting pesticide will only harm insects that have chitin in their exoskeletons and will not affect other insects.

Termiticide Examples

We will take a quick look at examples of termiticides used for soil treatment including cypermethrin, fipronil, fenvalerate, imidacloprid and permethrin. Any of these can be used to establish a chemical barrier that destroys or repels termites. Label directions for these materials should be followed closely for the concentration and rate of application to be used.

The judgment and experience of the termite specialist is important when selecting the termiticide that best suits the particular type of construction and the soil conditions. Below are descriptions of the various products and classes of chemicals that can be used in termite control.

Pyrethroids

The pyrethroids are a large family of modern synthetic insecticides similar to the naturally derived botanical pyrethrins. They are highly repellent to termites, which may contribute to the effectiveness of the termiticide barrier. They have been modified to increase their stability in the natural environment. They are widely used in agriculture, homes, and gardens. Some examples are bifenthrin, cyfluthrin, cypermethrin, deltamethrin, and permethrin. They may be applied alone or in combination with other insecticides. Pyrethroids are formulated as emusifiable concentrates (EC), wettable powders (WP), granulars (G), and aerosols.

Certain pyrethroids exhibit striking neurotoxicity in laboratory animals when administered by intravenous injection, and some are toxic by the oral route.

Systemic toxicity by inhalation and dermal absorption are low, however—there have been very few systemic poisonings of humans by pyrethroids.

Though limited absorption may account for the low toxicity of some pyrethroids, rapid biodegradation by mammalian liver enzymes (ester hydrolysis and oxidation) is probably the major factor responsible.

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Most pyrethroid metabolites are promptly excreted, at least in part, by the kidney. In response to dermal exposure, some persons may experience a skin sensitivity called paresthesia. The symptoms are similar to sunburn sensation of the face and especially the eyelids. Sweating, exposure to sun or heat, and application of water aggravate the disagreeable sensations. This is a temporary effect that dissipates within 24 hours.

First Aid
For first aid, wash with soap and water to remove as much residue as possible, and then apply a vitamin E oil preparation or cream to the affected area. Paresthesia is caused more by pyrethroids whose chemical makeup includes cyano- groups: fenvalerate, cypermethrin, and fluvalinate. In addition to protecting themselves from future exposure, persons who have experienced paresthesia should choose a pyrethroid with a different active ingredient, as well as a wettable powder or microencapsulated formulation.

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

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

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

Most pyrethrins and some pyrethroid products are formulated with synergists, such as piperonyl butoxide and MGK-264, to enhance the pesticidal properties of the product.

These synergists have no pesticidal effects of their own but enhance the effectiveness of other chemicals.
Pyrethrins, a single pesticide active ingredient, contain six components that have insecticidal activity: pyrethrin 1, pyrethrin 2, cinerin 1, cinerin 2, jasmolin 1, and jasmolin 2

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

Synergists include:MGK-264 and Piperonyl butoxide

Permethrin

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

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

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

Borates

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

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

Unlike most other wood preservatives and organic insecticides that penetrate best in dry wood, borates are diffusible chemicals—they penetrate unseasoned wood by diffusion, a natural process. Wood moisture content and method and length of storage are the primary factors affecting penetration by diffusion. Properly done, diffusion treatments permit deep penetration of large timbers and refractory (difficult-to-treat) wood species that cannot be treated well by pressure.

The diffusible property of borates can be manipulated in many ways; suitable application methods range from complex automated industrial processes to simple brush or injection treatments.

Application methods include momentary immersion by bulk dipping; pressure or combination pressure/diffusion treatment; treatment of composite boards and laminated products by treatment of the wood finish; hot and cold dip treatments and long soaking periods; spray or brush-on treatments with borate slurries or pastes; and placement of fused borate rods in holes drilled in wood already in use.

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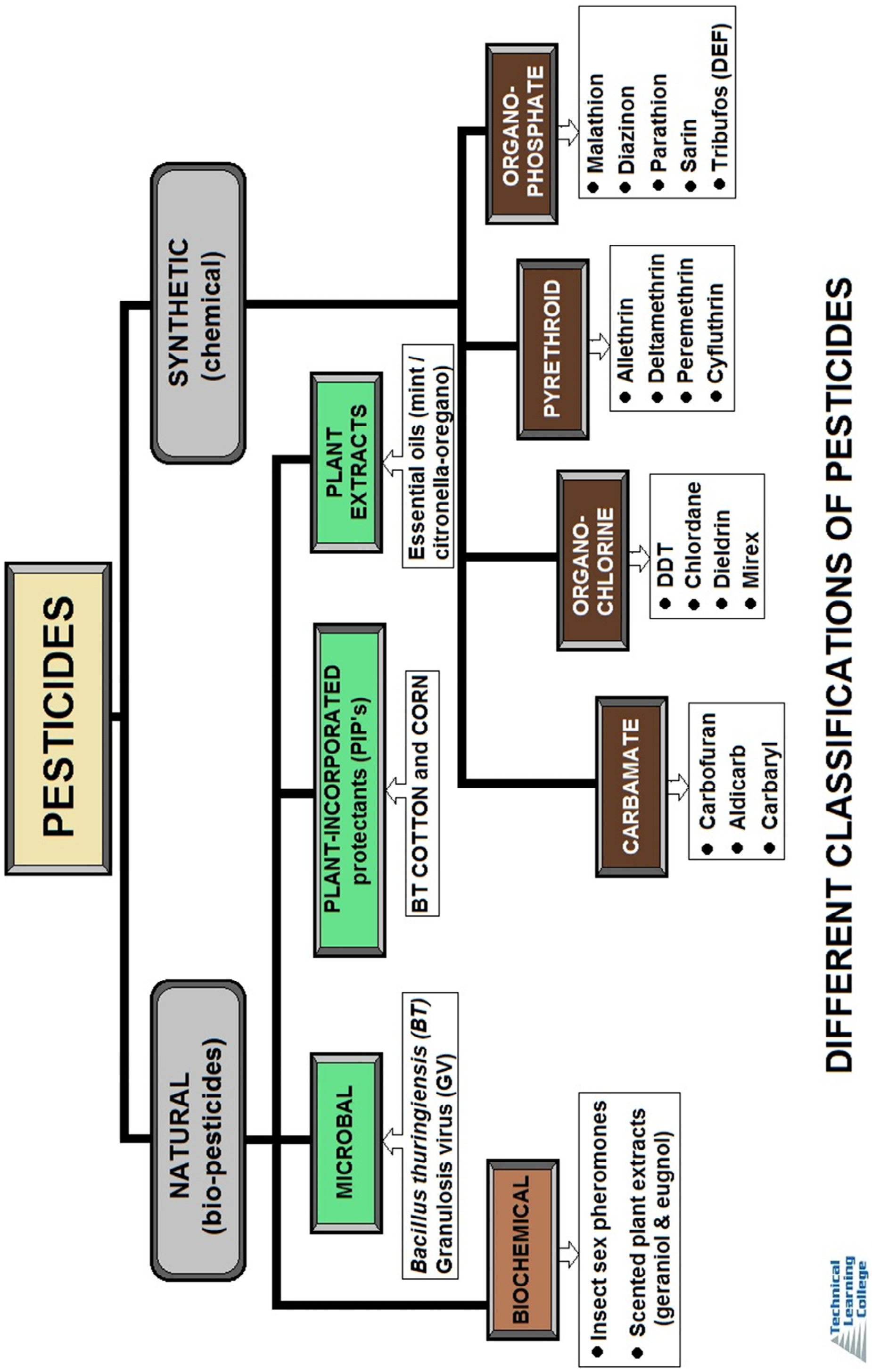
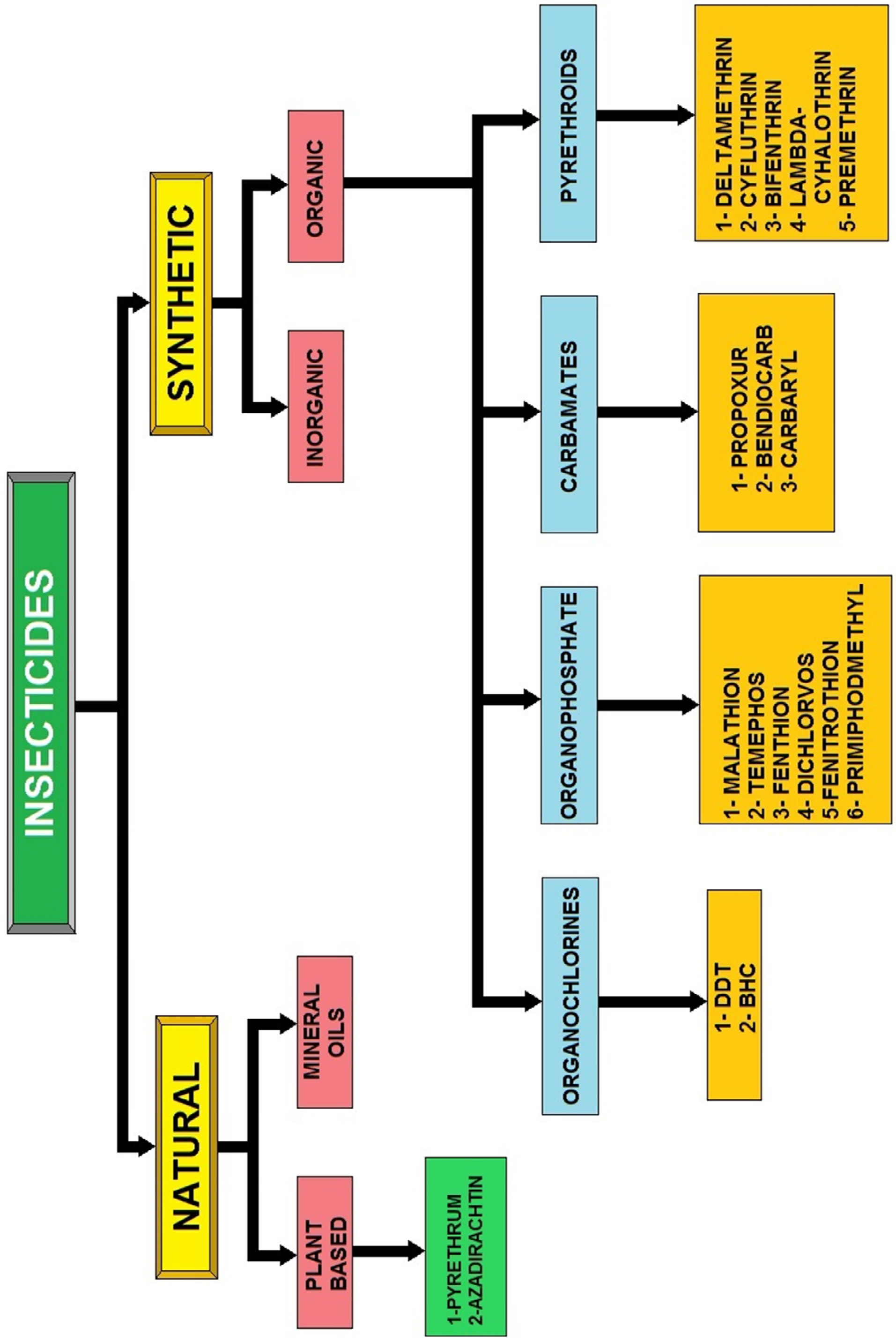

PESTICIDES
NATURAL (bio-pesticides)
SYNTHETIC (chemical)
MICROBAL
Bacillus thuringiensis (BT)
Granulosis virus (GV)
PLANT-INCORPORATED protectants (PIP's)
BT COTTON and CORN
PLANT EXTRACTS
Essential oils (mint / citronella-oregano)
BIOCHEMICAL
Insect sex pheromones
Scented plant extracts (geraniol & eugnol)
CARBAMATE
Carbofuran
Aldicarb
Carbaryl
ORGANO-CHLORINE
DDT
Chlordane
Dieldrin
Mirex
PYRETHROID
Allethrin
Deltamethrin
Peremethrin
Cyfluthrin
ORGANO-PHOSPHATE
Malathion
Diazinon
Parathion
Sarin
Tribufos (DEF)
DIFFERENT CLASSIFICATIONS OF PESTICIDES
Technical Learning College



PESTICIDES BASED UPON CHEMICAL COMPOSITION

Organophosphates and Carbamates Pesticides

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

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

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

These insecticide families are similar in their modes of action—they are all nervous system poisons. Insects and all other animals, including humans, have nervous systems that are susceptible. Both insecticide families are efficiently absorbed by inhalation, ingestion, and skin penetration. To a degree, the extent of poisoning depends on the rate at which the pesticide is absorbed.

Organophosphates break down chiefly by hydrolysis in the liver; rates of hydrolysis vary widely from one compound to another. With certain organophosphates whose breakdown is relatively slow, significant amounts may be temporarily stored in body fat. The organophosphates and carbamates replaced the chlorinated hydrocarbons (e.g., chlordane, aldrin, and heptachlor) for all uses, including termite control. Examples of organophosphates are chlorpyrifos for termite control and diazinon for other household pests. An example of a carbamate is carbaryl, also used for household and lawn pests.

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

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

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

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

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

Is there a medical test to show whether I was exposed to these pesticides?
The level of cholinesterase activity in red blood cells or plasma helps physicians determine exposure to these pesticides.

However, other chemicals or disease states can alter acetylcholinesterase activity. Urine or blood tests only apply if a person was exposed to a large quantity. Persons who will use these pesticides regularly should ask their physician to establish a baseline value prior to prolonged use, followed by monthly monitoring.

Acute Toxicity and Acute Effects
Acute toxicity of a pesticide refers to the chemical's ability to cause injury to a person or animal from a single exposure, generally of short duration. The harmful effects that occur from a single exposure by any route of entry are termed "acute effects." The four routes of exposure are dermal (skin), inhalation (lungs), oral (mouth), and the eyes. Acute toxicity is determined by examining the dermal toxicity, inhalation toxicity, and oral toxicity of test animals. In addition, eye and skin irritation are also examined.

Organophosphate Insecticides
Organophosphate insecticides include chlorpyrifos, diazinon, dimethoate, disulfoton, malathion, methyl parathion, and ethyl parathion. The carbamate compounds include carbaryl, carbofuran, methomyl, and oxamyl. Organophosphates and carbamates inhibit the enzyme cholinesterase, causing a disruption of the nervous system. All life forms with cholinesterase in their nervous system, such as insects, fish, birds, humans, and other mammals, can be poisoned by these chemicals.

Pesticide Poisoning
Insecticides cause the greatest number of pesticide poisonings in the United States. The most serious pesticide poisonings usually result from acute exposure to organophosphate and carbamate insecticides.

Seeking Medical Attention 1-800-222-1222

Pyrroles

Chlorfenapyr is the only termiticide from the pyrrole family of chemistry and is active primarily as a stomach poison with some contact activity. It is also non-repellent to termites. Chlorfenapyr is registered as a termiticide under the tradename Phantom®.

Chlorfenapyr acts on the mitochondria of cells and uncouples or inhibits oxidative phosphorylation, preventing the formation of the crucial energy molecule adenosine triphosphate (ATP). As a result, energy production in the cells shuts down, resulting in cellular and, ultimately, termite death.

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

Fiproles (or Phenylpyrazoles)

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

Pesticide Safety Procedures

- Mix the chemical outdoors or in a well-ventilated area. Mix only the amount you need.
- Keep children and pets away from areas where you mix or apply pesticides.
- Never mix different pesticides.
- Never eat, drink or smoke when working with pesticides.
- Wear rubber gloves, a long sleeved shirt, long pants, foot protection, goggles, a hat and preferable a mask when mixing and applying pesticides. Remember that pesticides can be absorbed into your body through the skin, as well as orally and through inhalation.
- Always shower and shampoo after working with pesticides. Wash your work clothes separately from the family laundry.
- Always keep the pesticides in the original container.
- Store pesticides in a ventilated, dry and cool place, preferably locked and away from children.
- Use all the pesticide in the container, do not pour unused pesticides down the drain.
- Triple rinse empty pesticide containers and use the residue for application. If the pesticide is a solid, shake the bag to remove and use all product before you dispose of the container.
- Do not store anything in an empty pesticide container and do not reuse the container.

Table 1. Insecticides commonly used for subterranean termite control (check with your State for restrictions)

Brand or trade names	Generic or common names	Dilution rates	Manufacturers
Available to professional pest control companies			
Demon TC	cypermethrin	0.25%	ICI Chemical Co.
Dragnet FT	permethrin	0.5-1%	FMC Chemical Co.
Dursban TC	chlorpyrifos	0.5-1%	Dow-Elanco Co.
Equity	chlorpyrifos	0.5-1%	Dow-Elanco Co.
Ficam[a]	bendiocarb	0.25%	Nor-Am Chem. Co.
Prevail FT[b]	cypermethrin	0.3-0.6%	FMC Chemical Co.
Pyrfon 6	isofenphos	0.75%	Mobay Chemical Co.
Torpedo	permethrin	0.5-1%	ICI Chemical Co.
Tribute	fenvalerate	0.5-1%	Roussel Bio Corp.
Available to general public			
Orthoklor Soil Insect & Termite Killer	chlorpyrifos	0.5%	Chevron Chem. Co.
Black Leaf Termite Killer	chlorpyrifos	0.5%	Black Leaf Products
Chlor-Guard Termite Preventor	chlorpyrifos	0.5%	Security Products

[a]Registered for spot treatment only
[b]Registered for pre-construction treatment only

We will go more into detail in the Advance Treatment Section.

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Signs and Symptoms

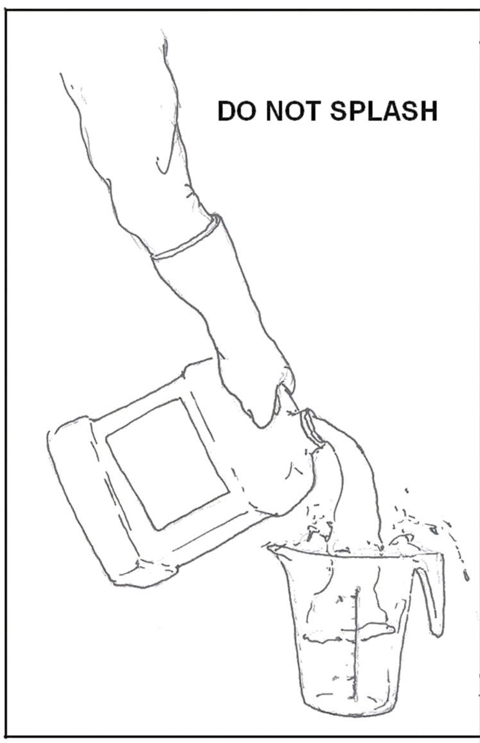
Acute Exposure for Insecticide Active Ingredients

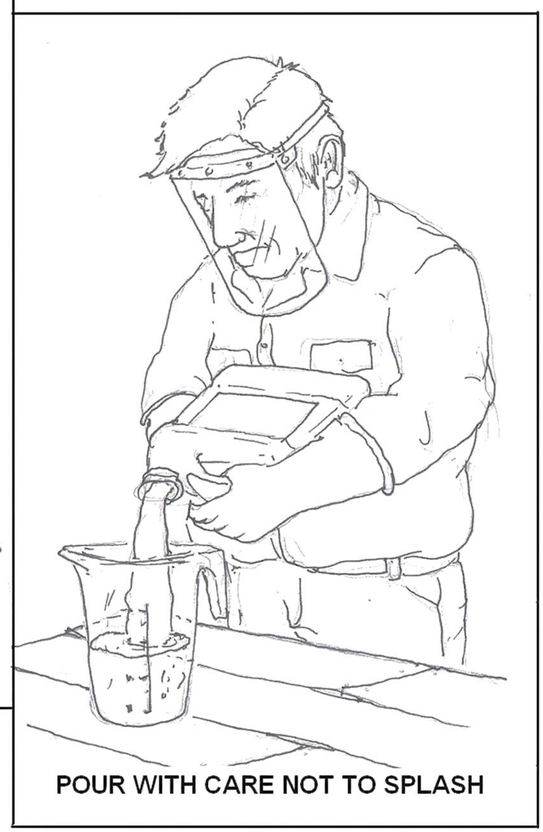
Active Ingredient	Brand Name	Signs and Symptoms
Acephate (organophosphate)	Orthene	Headache, excessive salivation and tearing, muscle twitching, nausea, diarrhea. Respiratory depression, seizures, loss of consciousness. Pinpoint pupils.
Aldicarb (N-methyl carbamate)	Temik	Malaise, muscle weakness, dizziness, sweating. Headache, salivation, nausea, vomiting, abdominal pain, diarrhea. Nervous system depression, pulmonary edema in serious cases.
Carbaryl (N-methyl carbamate)	Sevin	Malaise, muscle weakness, dizziness, sweating. Headache, salivation, nausea, vomiting, abdominal pain, diarrhea. Nervous system depression, pulmonary edema in serious cases.
Chlorpyrifos (organophosphate)	Dursban	Headache, excessive salivation and tearing, muscle twitching, nausea, diarrhea. Respiratory depression, seizures, loss of consciousness. Pinpoint pupils.
Endosulfan (organochlorine)	Thiodan	Itching, burning, tingling of skin. Headache, dizziness, nausea, vomiting, lack of coordination, tremor, mental confusion. Seizures, respiratory depression, coma.
Malathion (organophosphate)	Cythion	Headache, excessive salivation and tearing, muscle twitching, nausea, diarrhea. Respiratory depression, seizures, loss of consciousness. Pinpoint pupils.
Methyl Parathion (organophosphate)	Penncap-M	Headache, excessive salivation and tearing, muscle twitching, nausea, diarrhea. Respiratory depression, seizures, loss of consciousness. Pinpoint pupils.
Phosmet (organophosphate)	Imidan	Headache, excessive salivation and tearing, muscle twitching, nausea, diarrhea. Respiratory depression, seizures, loss of consciousness. Pinpoint pupils.

Signs and Symptoms

Acute Exposure for Insecticide Active Ingredients

Active Ingredient	Brand Name	Signs and Symptoms
Pyrethrins (natural origin)		Irritating to skin and upper respiratory tract. Contact dermatitis and allergic reactions--asthma.
yrethroids (synthetic pyrethrin)	Cypermethrin, permethrin	Abnormal facial sensation, dizziness, salivation, headache, fatigue, vomiting, diarrhea. Irritability to sounds or touch. Seizures, numbness.





Insect Growth Regulators - Introduction

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

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

Biotermiticides
Biotermiticides — such as fungi, nematodes, bacteria, and so forth—still need further research and development to maximize their potential. Metarhizium anisopliae can be injected into galleries, infested walls, and other moist areas where the humidity accelerates the fungal growth. Several forms of nematodes are sold for termite suppression. Nematodes are applied to the soil or directly into mud tubes. As with all new methods of control, more research is needed to determine the advantages and limitations of such organisms.

Biotermiticide, which is derived from fungi, bacteria or nematodes, is injected into active gallery sites. It then develops on the infected foraging termites and spreads among the colony. Suitable temperature and moisture, early detection and avoidance are factors that determine this treatment's success. It may provide localized area control or, with optimum conditions, may suppress a colony.

Nematodes are roundworms, or threadworms (the Greek word nema means thread) in the phylum Nematoda. Some species live as parasites inside the bodies of insects and other organisms, often with no observable effect on the hosts. Others cause effects ranging from minor discomfort to disease and death.

Entomophilic nematodes have affinities for insect hosts. Entomopathogenic nematodes (EPN) produce observable deleterious effects.

Certain entomopathogenic nematodes (EPN) are efficient biological control agents that can be used against subterranean termites. That fact has been obscured by tests that emphasized soil-drench (inundative) treatment methods. Recent tests using EPN as inoculums in specially-designed nematode-optimized termite interceptors show that they reliably suppress even large, vigorous termite colonies.

Because EPN do not elicit complex avoidance reactions in termites exposed to them, repeated inoculations in such devices should succeed, over time, in eliminating termite colonies entirely. Furthermore, EPN should perform well as termite colony inoculants in all climates and environments suitable for termite propagation, without the need for exotic toxicant adjuncts.

Among the insect growth regulators are juvenile hormone analogs (JHA), juvenile hormone mimics (JHM) and chitin synthesis inhibitors (CSI). These products disrupt the termites by causing a specific response or behavior within the colony or by blocking the molting process. Remember that all insects, including termites, have an exoskeleton made primarily of chitin. In order to grow, they must periodically shed their chitinous exoskeletons and form new ones. This process is called molting. A chitin synthesis inhibitor slowly builds up in the termite and, the next time a molt should occur, prevents proper formation of the cuticle. IGRs are the slowest of the bait types but have greater impact on the colony.

In some cases, these agents are released into the soil and in other cases they are injected into the above-ground termite galleries. As with all new methods of control, more research is needed to determine the advantages and limitations of such organisms. Bacillus thuringiensis or B.t. is an example of a commonly used biological control agent.

Liquid Formulations
Liquid formulations are generally mixed with water, but in some instances labels may permit the use of crop oil, diesel fuel, kerosene, or some other light oil as a carrier. This section will present more detailed information about the common liquid pesticide formulations.

Aerosols (A)
These formulations contain one or more active ingredients and a solvent. Most aerosols contain a low percentage of active ingredients. There are two types of aerosol formulations: the ready-to-use type commonly available in pressurized, sealed containers and those products used in electric- or gasoline-powered aerosol generators that release the formulation as a “smoke” or “fog.”

Liquid Baits
An increasing number of insecticides and rodenticides are being formulated as liquid baits. Liquid rodenticides are mixed with water and placed in bait stations designed for these products. They have two major benefits. Liquid rodenticides are effective in controlling rodents, especially rats, in areas where they cannot find water. They are also effective in areas of poor sanitation where readily available food renders traditional baits ineffective.

Dry or Solid Formulations
Dry formulations can be divided into two types: ready-to-use and concentrates that must be mixed with water to be applied as a spray. This section will present more detailed information about the common dry or solid pesticide formulations. Dusts (D) Most dust formulations are ready to use and contain a low percentage of active ingredients (usually 10% or less by weight), plus a very fine, dry inert carrier made from talc, chalk, clay, nut hulls, or volcanic ash. The size of individual dust particles varies.

Granules (G)
Granular formulations are similar to dust formulations except granular particles are larger and heavier. The coarse particles are made from materials such as clay, corncobs, or walnut shells. The active ingredient either coats the outside of the granules or is absorbed into them. The amount of active ingredient is relatively low, usually ranging from less than 1 to 15 percent by weigh.

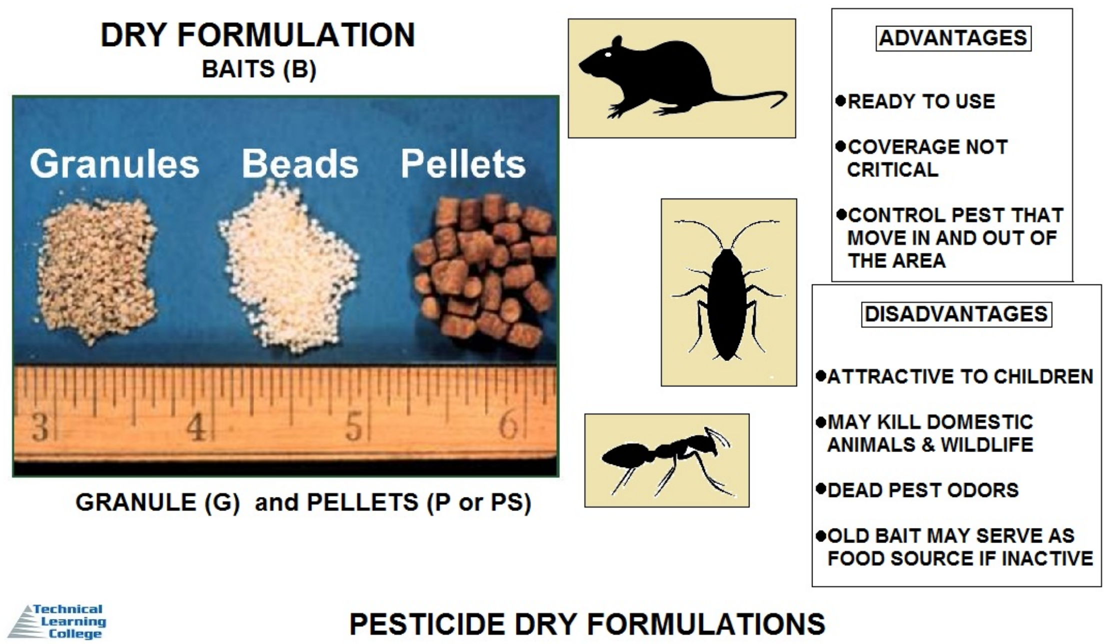
TERMIDOR FOAM
EXCELLENT TERMITICIDE

Foaming Agents
Foam formulations of soil-applied termiticides can deliver termiticide to areas difficult to reach with liquid formulations. Borates are foamed for application in wall voids. Foams penetrate into hard-to-reach cavities and voids, and they improve termiticide distribution in soils. The most difficult area to achieve uniform and continuous insecticide distribution is under slabs, where the termite control specialist is unable to see the actual deposition of the termiticide.

Foam applications can reduce the need for corrective treatments, especially under slabs. The liquid termiticide is combined with air to create uniform, small-diameter bubbles. The foam carries the liquid termiticide in the spaces between the bubbles.

As the foam breaks down it leaves a thin residue on the surfaces it had contact with. The fact that foam is less dense than liquid enables it to dispense uniformly. The foaming agent delays collapse of the bubbles, providing more time for the insecticide to reach desired areas. Underneath a slab, gravity deposits most of the liquid on the soil, with a small portion of the residue on other surfaces (such as the underside of a concrete slab) in the treated areas.

Foam treatments do not replace other soil applications (they supplement these applications so that gaps left by conventional treatments can be successfully treated. Foams are being used to treat—or retreat—critical areas such as unevenly filled porches, which liquids might not reach or cover uniformly. Foams may be used in initial treatments to ensure the most complete termiticide barrier in critical as well as hard-to-reach areas, thus reducing the treatment failures that may occur with the use of soil-applied termiticides alone.



Fumigation Introduction

Pests that can be treated with fumigation include drywood termites, Anobiid powder post beetles (usually in softwoods such as floor joists, etc.), Lyctid powder post beetles (sapwood of hardwoods such as moldings, cabinets, and flooring), and old house borers (sapwood of softwoods in beams, rafters, etc.). We will cover this more in the advanced section of the course.

Advantages of Fumigation

Fumigation has several advantages over other pest control procedures:

- Fumigants are usually quick acting and eradicate the pest.
- Fumigants diffuse through all parts of the structure or commodity being treated and thus reach pest harborages that cannot be reached with conventional pest control materials or techniques.

For certain pests/commodities, fumigation is the only practical method of control.

GREAT CARE WHEN FILLING WITH PESTICIDES

Disadvantages of Fumigation

For several reasons, fumigation may not be the best means of pest control:

- The control achieved through fumigation is temporary. There is no residual action from fumigants, and as soon as the fumigation is completed, the structure or commodity is susceptible to re-infestation.
- Fumigants are toxic to humans and special precautions must be taken to protect fumigators and the occupants of fumigated structures.
- Fumigants must be applied in enclosed areas, so application requires additional labor.
- Fumigation must not be attempted by one person. Additional labor is required.

Some commodities or pieces of equipment may be damaged by certain fumigants and must be either removed or protected.

- The special training required for all members of the fumigation crew adds to fumigation costs.
- Occupants of the structure being fumigated usually must vacate the building for a number of hours.
- This may be inconvenient.
- Fumigation requires special licenses and certification.

Termite Bait Application Introduction

There are several termite baits on the market that add to the arsenal of tools available for managing termite populations and protecting structures. Baits work on the principle that foraging termites will feed on a treated cellulose material, which eventually kills the termites and possibly the colony. The toxic material in the bait must kill slowly enough to allow foraging termites to return to the colony and spread the bait through food sharing (trophallaxis).

ADVANCED BAITING SYSTEM EXAMPLE

Because dead termites repel other termites, the toxic material also must kill slowly enough so that dead termites do not accumulate near the bait. Baits control a colony locally—either eliminating it or suppressing it to the point that it no longer damages a structure. To be successful, the products must be non-repellent, slow acting and readily consumed by termites.

Three main types of bait products are available:

- Ingested toxicants or stomach poisons.
- Biotermiticides or microbes.
- Insect growth regulators (IGRs).

Each type has unique features and is used differently in termite control programs. Ingested toxicants have the quickest effect, though dose dependency and learned avoidance may limit this type of product to termite reduction in localized areas.

Biotermiticides, derived from fungi, bacteria, or nematodes, are injected into active gallery sites. They then develop on the infected foraging termites and spread among the colony.

Suitable temperature and moisture, early detection, and avoidance are factors that determine this treatment's success. It may provide localized area control or, with optimum conditions, may suppress a colony.

Among the insect growth regulators are juvenile hormone analogs (JHA), juvenile hormone mimics (JHM), and chitin synthesis inhibitors (CSI).

These products disrupt the termites by causing a specific response or behavior within the colony or by blocking the molting process.

Remember that all insects, including termites, have an exoskeleton made primarily of chitin. To grow, they must periodically shed their chitinous exoskeletons and form new ones. This process is called molting.

A chitin synthesis inhibitor slowly builds up in the termite and, the next time a molt occurs, prevents proper formation of the cuticle. IGRs are the slowest acting of the bait types.

Commercial Baiting Products

Sentricon™ System
Sentricon™ System, developed by Dow AgroSciences for professional use, combines monitoring with the use of permanent stations. Stations are installed in areas where termites exist and around the perimeter of a structure and in the yard. Each station contains a wood stake and must be periodically monitored for termite activity.

After termites attack, the wood is removed and replaced with a bait tube. Termites from the wood must be transferred to the bait tube, which is left in the station until termite activity ceases. Then the bait tubes are replaced with new wood stakes and monitoring for new infestations resumes.

Thus, the Sentricon™ System protects property through an integrated program of monitoring, baiting when termites are present and resuming monitoring when termites are no longer present. The active ingredient in the Sentricon™ System is hexaflumuron, a chitin synthesis inhibitor. The philosophy behind the Sentricon™ System is that foraging pseudergates will feed on the bait, return to the colony and pass the bait to other colony members through trophallaxis. Dow AgroSciences claims that with the Sentricon™ System, colony elimination is possible.

FirstLine™ Termite Bait Stations
FMC Corporation manufactures bait stations for suppression of subterranean termite colonies. The FirstLine™ aboveground termite bait station is applied directly to active termite infestations. It is placed above ground, inside or outside, at the leading edge of active termite mud tubes.

Another product, the FirstLine™ GT in-ground bait station, is placed in the ground in areas conducive to termite attack and acts as a first line of defense against termite invasion of a structure. There are two types of these in-ground bait stations. One type has wood stakes for monitoring the presence of termites. The other type has cardboard treated with sulfluramid. Bait stations are placed in areas where termites are present or very close to monitoring stations that have been attacked by termites.

The active ingredient in FirstLine™ termite bait stations is sulfluramid, a slow-acting stomach poison. The philosophy behind the FirstLine™ products is that many termites will feed on the bait and over time will die.

Research with these bait stations demonstrates that reduction of the termite population is possible, but not elimination. FMC Corporation also markets Interceptor™, an on-the-wall application. This product is placed over a termite tube. The tube is broken open to allow termites to have access to the bait. The active ingredient is sulfluramid.

Exterra® Termite Interception and Baiting System
Ensystex Incorporated manufactures a termite baiting system called Exterra® Termite Interception and Baiting System. The in-ground stations are designed to permit visual inspection without removing or disturbing the stations. The chitin synthesis inhibitor

diflubenzuron (Labyrinth®) is the active ingredient in the bait matrix, a shredded paper towel material.

Subterfuge® Termite Bait
BASF manufactures Subterfuge® termite bait with hydramethylnon as the active ingredient mixed into bait matrix. This baiting system places the active ingredient in the ground at the same time the station is placed in the ground. Hydramethylnon is a member of the amidinohydrazone family of chemistry and is primarily active as a stomach poison. It is also non-repellent to termites. It works on the mitochondria of cells and ultimately shuts down energy production, resulting in death in a manner similar to chlorfenapyr.

BioBlast™
An example of a biotermiticide is BioBlast™, manufactured by EcoScience. BioBlast™ is an EPA registered wettable powder containing live spores of the insect killing fungus Metarhizium anisopliae. This product is injected into the termite galleries. The spores germinate, penetrate the cuticles of termites and kill them. Spores are carried throughout the colony in a manner known as "horizontal transfer." BioBlast™ controls termites in localized areas if conditions are right for the fungus to grow.

CARRY THE SDS AND LABEL AT ALL TIMES

More on Bait Technology

Baits
Bait technology uses wood or a cellulose matrix favored by termites that is impregnated with a slow-acting toxic chemical. Termite workers feed upon the bait and transfer it to other colony members by grooming or trophallaxis, eventually reducing or eliminating the entire colony. Termites are not site-specific, but rather, they forage among various food sites, which results in the bait being encountered by many colony members. The toxicant necessarily is slow acting because termites tend to avoid sites where sick and dead termites accumulate.

Typically, in-ground stations are inserted in the soil next to the structure and near known or suspected sites of termite activity. In-ground stations often initially contain untreated wood that serves as a monitoring device. The monitoring wood is replaced with the toxicant once termites have been detected feeding on it. In addition, aboveground stations may be installed inside or on the structure in the vicinity of damaged wood and shelter tubes. Aboveground stations initially contain bait.

It is very important that bait systems are properly installed and diligently serviced. Monthly inspections of a baiting system usually are necessary, except during inclement winter weather. Successful termite baiting necessitates proper monitoring and maintenance of the stations. Baits work much more slowly than soil termiticides, and the homeowner should be aware of the possibility of a lengthy baiting process. Several months or more may elapse before the termites locate stations, then termites must feed on sufficient amounts of the toxicant.

An often-cited advantage of termite baits is that they are "environmentally-friendly" because they use very small quantities of chemical and decrease the potential for environmental contamination. In addition, bait application causes little disruptive noise and disturbance compared to soil treatments. Furthermore, baits can be used in structures with wells or cisterns, sub-slab heating ducts, and other features that may preclude a soil treatment. Baits are often used in sensitive environments.

A number of baits have been marketed to control termites. Bait products that are available for licensed pest management professionals include the Sentricon® Termite Colony Elimination System (hexaflumuron [Recruit® II bait] or noviflumuron [Recruit® III bait]), FirstLine® Termite Defense System (sulfluramid), Exterra® Termite Interception and Baiting System (diflubenzuron [Labyrinth® bait]), Subterfuge® Termite Bait (hydramethylnon), and Outpost® Termite Bait Response (diflubenzuron). Not all of these bait systems are equally effective. It is advisable to review the independent research that has been conducted on a particular bait, as some products have been evaluated much more rigorously than others.

Spectracide Terminate® (sulfluramid) and Termirid® 613 (borate) can be purchased by homeowners. However, Terminate® is not recommended as sole protection against termites, and an active infestation should be treated by a professional. Termirid® can be used to reduce subterranean termite populations.

Little or no research has been conducted to verify the effectiveness of these products, particularly when used by homeowners.

When deciding whether or not to use baits, it is important to remember that this is a relatively new technology. Baits are still being evaluated and their long-term success is unproven. However, the concept of controlling termites with baits is promising. You, the termite control professional, must determine which approach, colony elimination or suppression, will succeed in each situation.

Baits may require from a few weeks to several months to control termites, depending on such factors as the product selected, application timing, the time to discovery by the termites, the amount of feeding the colony does, colony size and other control measures used.

Baits fit well in an integrated pest management (IPM) control program, along with eliminating conditions conducive to termite infestation, judicious use of liquid soil products as a spot or limited barrier application and use of wood treatment products. An IPM program will require more frequent visits to the site for monitoring and to provide ongoing service. Applicators are strongly encouraged to familiarize themselves with bait technology and future products.

Drilling is hard work; there are days you might drill every day, it is best to work as a two-man team if you are doing termite treatments. Beware of hitting rebar and deep footers. After your first inspection, draw a detailed plan of action and map your treatment methods, this is required by law and good for your records and customers as well. Subs are easy to kill if you do a good treatment. It might take a month but if termites are treated correctly, Subs are walking dead.

Termite Product Application – Treatment Instructions

Building With a Basement and Crawl Space

Basement: For an interior vertical barrier, drill the floor slab and space holes about one foot apart. Drilling may be required along the foundation walls, along one side of partition walls, along both sides of load-bearing wall, around sewer pipes, floor drains, conduits, and any crack in the basement floor. Using a sub-slab injector, inject the insecticide at the rate of 4 gallons per 10 linear feet. For an insecticide barrier around the exterior of foundation walls, apply an insecticide by rodding and/or trenching. The rod holes should be spaced 1 to 1 1/2 feet apart to provide a continuous chemical barrier. If a trench is necessary, it should not be wider than 6 inches. Inject insecticide using rodding technique at the rate of 4 gallons per 10 linear feet. Cover the trench with untreated soil.

Crawl Spaces

Establish vertical barriers by rodding and/or trenching procedures. A shallow trench should not be wider than 6 inches. Space rod holes about 1 to 1 1/2 feet apart. Apply insecticide at the rate of 4 gallons per 10 linear feet per foot of depth. Do not treat soil in crawl space area with a broadcast insecticide spray.

Hollow Masonry Units of the Foundation Walls

Treat through masonry voids to provide a continuous chemical barrier at the top of the footing. When treatment is necessary, access holes must be drilled through mortar joints below the sill plate, as close as possible to the footing. Apply insecticide at the rate of 2 gallons per 10 linear feet. Plug all holes with mortar or any other special compound.

Bath Traps

Soil may require insecticide treatment if it is exposed beneath and around plumbing/waste pipe entrances through a concrete slab. Remove any wood or other debris and treat the soil by rodding or flooding with an insecticide solution.

Treatment Near Ponds, Wells, Cisterns, and Faulty Foundation Walls, Around Pipes or Utility Lines

Insecticide applications through rodding is discouraged in such situations. The suggested procedure is to make a trench and remove the soil to be treated onto a heavy plastic sheeting or similar material. Treat the excavated soil with insecticide at the rate of 4 gallons per 10 linear feet per foot of depth. Mix the soil with insecticide and replace it in the trench. Cover the treated soil with a thin layer of untreated soil. In the case of wells, ponds, and cisterns, if a rodding technique is necessary, the distance between the treated area and the water source should be 50 feet or more.

Wood Treatment

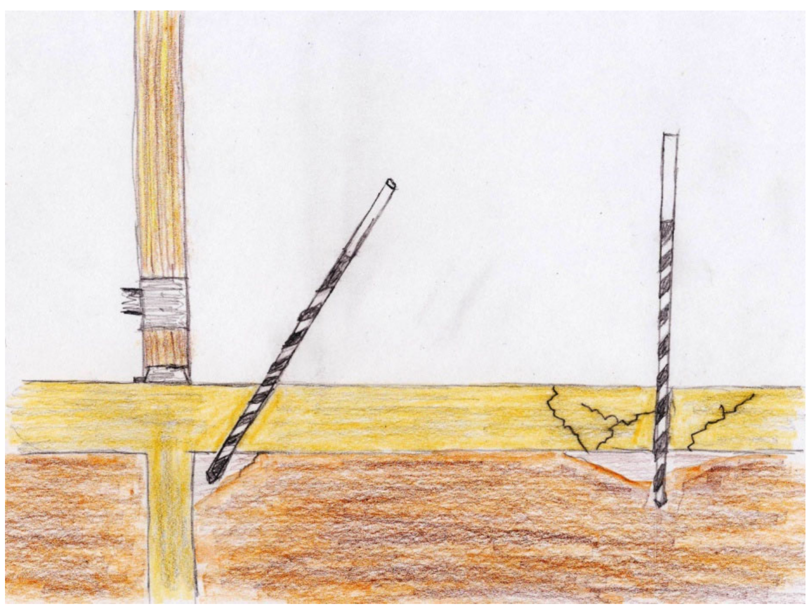
In addition to soil treatment, it may be necessary to treat infested wood with insecticide spray or injection. Applications are made to inaccessible areas by drilling and then injecting the insecticide solution. Broadcast spray must be limited to wood in attics, crawl spaces and unfinished basements or similar unoccupied areas.

Treatment of Secondary Subterranean Termite Colony

Apply insecticide to infested wood and void spaces with a crack and crevice injector.

Carefully measure and mix the product and always use your air gap water protection device. So many applicators risk damaging the public water supply if they do not follow instructions and do not utilize the air gap protection device. Most applicators do not carefully measure the product to the instructions, this a not cost effective and usually the owners or managers are the ones need to properly instruct the chemical usage. I think this chemical costs about 80 cents an ounce and that doesn't seem to be that much but if you are wasting two or three dollars per job, that will cut the profit and may indeed end someone career.

You need to properly identify the pest target, so many applicators treat subs with drywood methods and these methods will not work. Subs live under the slab. Pull the carpet up and drill down. Control of subterranean termites in buildings can be difficult and expensive. Chemical (termiticide) treatment is a proven means of protecting buildings from further damage by subterranean termites. The majority of treatments involves injection of a termiticide around the entire perimeter of the foundation and under the slab (called a full treatment) or may only require a partial treatment of the perimeter if the infestation is very localized. Some termiticides can be sprayed if the infestations are suited to this type of treatment. Therefore, as previously mentioned, it is important that a correct diagnosis and thorough inspection be made before any control measures are implemented.



You must drill pass the concrete slab into order to reach the termites.

Drilling and dusting the wall voids will help control subs. Always follow the State rule and the manufacturer's label instructions. Some of my suggestions may not be allowed with certain chemicals and in certain States with California being the strictest. There are several products that I can think of that will destroy subs but few manufacturers will list it on the label. When in doubt, follow the label. This type of treatment will also kill bed bugs and cockroaches. Below, is an example of trenching and drenching or some will say "rodding". This professional is wearing proper respiratory protection but needs gloves while pumping 4 gallons of chemical for every ten feet of trench to kill subs.

Termite Prevention

Preventive practices are a critical aspect of termite control management. Prevention of subterranean termite infestation of wooden structures centers upon disrupting their ability to locate moisture, food (wood), and shelter. Avoid moisture accumulation near the foundation, which provides water needed for termite survival. Divert water away from the foundation with properly functioning downspouts, gutters, and splash blocks. Soil needs to be graded or sloped away from the foundation in order for surface water to drain away from the building.

Cellulose
Cellulose (wood, mulch, paper, etc.) that is in contact with soil provides termites with ready and unobservable access to food. It is very important to eliminate any contact between the wooden parts of the house foundation and the soil. Maintain at least 6 inches between the soil and porch steps, lattice work, door or window frames, etc. Never stack or store firewood, lumber, newspapers, or other wood products against the foundation or within the crawl space. Prevent trellises, vines, etc. from touching the house. Before and during construction, never bury wood scraps or waste lumber in the backfill, especially near the building. Be sure to remove wooden or cellotex form boards, grade stakes, etc. used during construction. Remove old tree stumps and roots around and beneath the building. Avoid or minimize use of wood mulch next to the foundation.

Soil Barrier Termiticides
Conventional soil treatments rely on creating a chemical barrier in the soil that is toxic to termites when they come into contact with it. Many also have repellent characteristics which causes the termites to avoid treated soil. To achieve termite control for long periods of time, such termiticides must be applied as a continuous barrier in the soil next to and under the foundation. If there are untreated gaps in the soil, termites may circumvent the chemical treatment. Hence, such treatments during preconstruction can provide for more uniform coverage. Once a home is constructed, the chemical has to be injected through drill holes and trenching around the foundation, which can result in less accurate coverage. Effective termite control usually requires specialized equipment and often 150 or more gallons of prepared termiticide solution per house, depending on size, basement, etc.

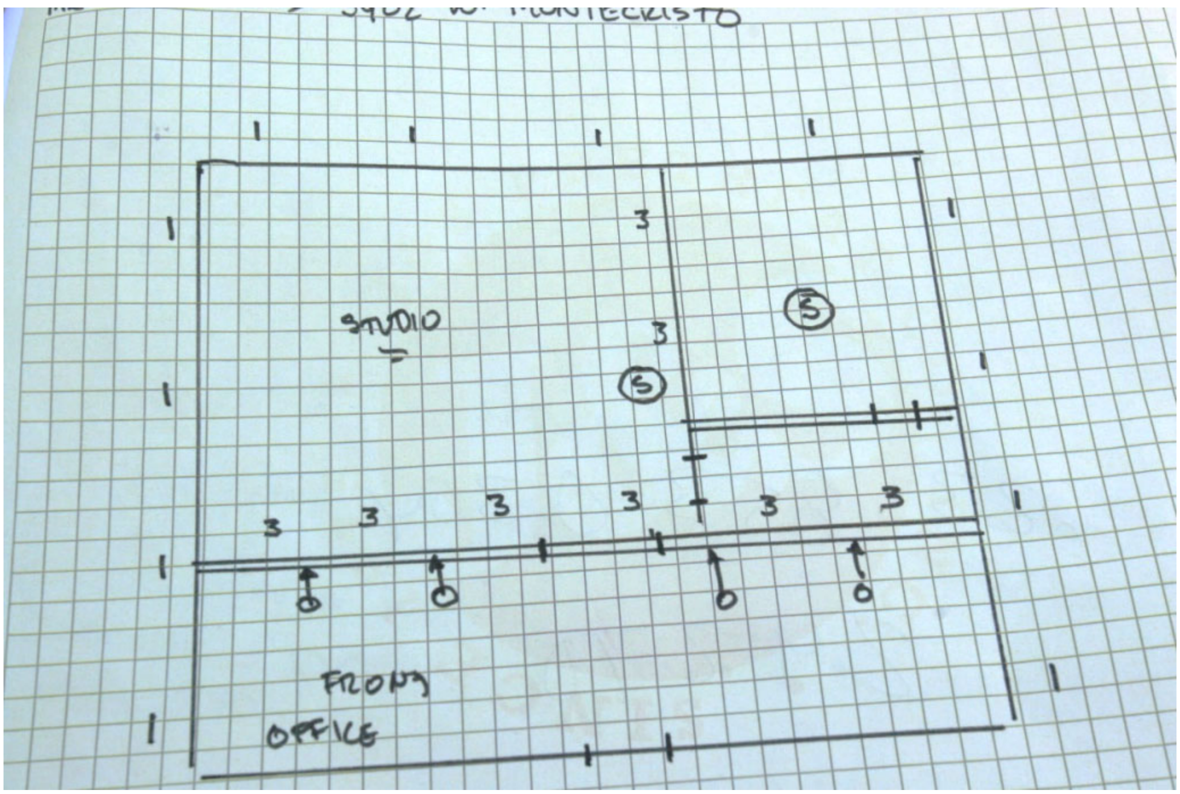
Termiticides that act by creating a chemical barrier in the soil include bifenthrin (Talstar®), cypermethrin (Demon®, Prevail®), and permethrin (Dragnet®, Prelude®). Chlorpyrifos (Dursban®) can be used only during preconstruction and only until December 31, 2005.

In reference to "**spot treatments only**" (using chemical barrier termiticides only in areas of the house where termites are seen), most pest management firms will refuse such treatments or will not guarantee them. The reason is that termites have a very high probability of finding other untreated points of entry into the structure.

Localized spot treatments are considered risky except in re-treatment situations.

Treated-Zone - Termiticides
The most recent termiticides to be marketed are non-repellent to termites, but show delayed toxicity as termites forage through treated soil, which they do not avoid. As termites penetrate the "treated zone," they contact the active ingredient, which causes delayed mortality and also possibly allows the termites to be overcome by lethal microbes.

Furthermore, the toxicant is thought to be passed to nest mates through grooming activities and social food exchange (trophallaxis). Control usually is achieved within 3 months. As with soil barrier termiticides, specialized application equipment and large volumes of chemical solution are needed. Non-repellent termiticides include fipronil (Termidor®), imidacloprid (Premise®), and chlorfenapyr (Phantom®).



TERMITE TREATMENT ZONE RECORD

There are several methods of patching the drill holes. Many applicators prefer the caulking type of patch but others like to mix cement and do it the old-school way. Either way, termite treatment is a hard way to make money. It is good money but long and hard work. The good news, there are more termites and they seem to be thriving.

Every day I am able to find subs and drywoods attacking both homes and businesses. I think it is best to purchase two of the best hammer drill and bits you can afford. It is no fun to run in to a well-poured slab or rebar. I prefer the 4-inch thick slabs but they are rare.

Required Inspection
By state law, the minimum requirement for termite inspections includes visual searches of accessible areas. However, detection of difficult-to-find infestations may require removing walls, paneling, and stucco, as well as using ladders and scaffolds.

Read the pesticide product label - The label tells you exactly how the product is to be used and provides information on potential risks. If the label does not include directions to control termites and protect the structure, then the product is not intended to protect the structure against termites and should not be applied. If you wish to see a copy of the product label, ask the company representative for a copy. Always be prepared to provide a copy of the label information to the business or homeowner. We cannot stress the dangers of pesticide application and the high death and injury rate due to applicators not following label instructions.

Be aware of the how soon you can return to the treated residence - The time required before the residence can be re-occupied will vary by product and will be indicated on product labels. Make sure to inform the business or homeowner when it is safe to reenter the building.

Whatever termite treatment, always write down everything you did, take photographs and file properly label these to protect yourself. Even if you did a perfect job!

Carefully write the chemical amounts and document the areas you did not treat.

Both the State and the customers like to see this professionalism. Of course, paperwork takes a large percentage of time, but it is an insurance policy and covers your rear end if something comes back.

There are lawyers that specialize in freedom of information laws and will inspect State files and customer's complains in order to find a lawsuit. These lawyers look for ways to sue pesticide applicators, primarily the owners of the company and the pesticide manufacturer.

One area that needs attention...you as a professional (PCA) need to develop a relationship with the State Agency in order to call and make important concerns known to the State before these concerns come back on you.

Alternative Termite Controls

Treated Wood

Borates (disodium octaborate tetrahydrate [Tim-bor®, Bora-Care®, Jecta®], Impel®) and pressure-treatments (creosote, chromated copper arsenate [CCA]) protect wood against termites and wood-decay fungi. However, even creosote-treated railroad ties and telephone poles, and CCA-treated wood, over time, can be subject to termite attack. Termites can build mud tubes over treated surfaces. Furthermore, they can gain entry through cut and cracked ends or areas where the chemical has not sufficiently penetrated.

Wood treatments are primarily used to supplement other termite control measures, because termites are able to attack untreated wood in other areas of the structure. It is advisable to use pressure-treated wood in situations where wood is in direct contact with soil or is exposed to rainfall. Borates are fairly soluble in water, so borate-treated wood should be protected from constant rewetting.

Borates may be applied to wood by homeowners. As of 1 January 2004, CCA-treated wood is no longer available for use in most residential settings because of concerns regarding its arsenic content.

Physical Barriers

Physical barriers are particularly appropriate during the preconstruction phase to provide protection of the structure from subterranean termites. One such physical barrier is stainless-steel wire mesh (TermiMesh®) that is fitted around pipes, posts, or foundations. The newest physical barrier, Impasse® Termite System, contains a liquid termiticide (lambda-cyhalothrin) locked between two layers of heavy plastic that is installed before the concrete slab is poured. It is supplemented with Impasse® Termite Blocker, which uses special fittings around plumbing and electrical pipes and conduits.

Biological Control Agents

Certain species of parasitic round worms (nematodes) will infest and kill termites and other soil insects. They have been promoted and marketed by a few companies. Although effective in the laboratory, control is often quite variable under field conditions. Limited success with nematode treatments may be attributed to the ability of termites to recognize and wall-off infected individuals, hence limiting the spread of nematodes throughout the colony.

Furthermore, soil moisture and soil type appear to limit the nematode's ability to move in the soil and locate termites. A fungus Metarhizium anisopliae (Bio-Blast®) is a biological termiticide that requires special application and handling techniques. It is labeled for aboveground application to termite infestations in structures, but it is not labeled for application to the soil.

Spray effectiveness is enhanced when applied to many foraging termites because infected termites can pass the fungus to nest mates. However, it is difficult to infect a large enough number of termites for the infection to spread throughout the colony. Furthermore, it provides no long-lasting residual activity, and the fungal spores die with the dead termites.

Insufficient research has been conducted to indicate whether this is an effective method for controlling termites.

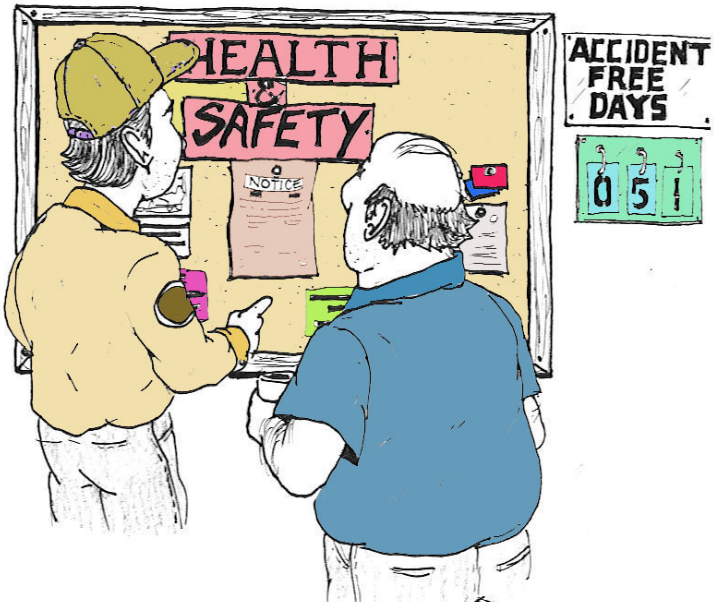
Elimination of Dursban Pesticide for Nearly all Household Uses

To protect children and public health, the EPA and the manufacturer of the pesticide Dursban have agreed to eliminate its use for nearly all household purposes and to move to significantly reduce residues of it on several foods regularly eaten by children.

Dursban, also known as chlorpyrifos, is the most widely used household pesticide produced in the U.S. It is an ingredient used for a broad range of lawn and home insecticide products, for agricultural purposes, and for termite treatment.

Under the agreement, production will cease and there will be a phase-out of all home, lawn and garden uses, as well as the vast termite control uses.

"Chlorpyrifos is part of a class of older, riskier pesticides, some going back 50 years. Exposure to these kinds of pesticides can cause neurological effects. Now that we have completed the most extensive evaluation ever conducted on the potential health hazards from a pesticide, it is clear that the time has come to take action to protect our children from exposure to this chemical," said EPA Administrator Carol M. Browner.



The agreement mandates that all uses will be phased out this year in areas where children could be exposed, including schools, daycare centers, parks, recreation areas, hospitals, nursing homes, stores and malls. In addition, the agreement calls for canceling or significantly lowering allowable residues for several foods regularly eaten by children, such as tomatoes, apples and grapes. These actions will be taken by the beginning of the next growing season.

Topic 2 – Termite Section Post Quiz

Termites
1. Flying ants and swarming termites are often difficult to distinguish when these insects are seen around residential and commercial buildings.
True or False

2. Which species of termites are the most destructive of all termite species, account for 95% of the damage?

3. Workers are creamy white, soft-bodied, wingless, and blind.
True or False

Termite Life
4. The single female can easily start a new colony on her own. Establishment of a colony is dependent upon the survival of both the queen in the nest site and that she has successfully mated.
True or False

Communication in the Colony
5. Western subterranean termite workers look like white or cream-colored ants. Swarmers are about 3/8-inches long (wings included), and their body is dark brown. They have two pairs of wings, and the front wings are larger than the hind wings. Soldiers have an orange, rectangular-shaped head with large pincher- like mouthparts that are used to fight off colony invaders.
True or False

6. Ants have one pair of transparent wings with many veins and are of equal length, and often have a light patch along the outer margin of the front wing, whereas the wings of termites are about equal in length (8-9 mm) and have many fine veins.
True or False

7. Western subterranean termites have acute survival instincts. If they are shaken up or disturbed, the termites often will abandon the associated area and move on to secretly cause damage in other areas in the building.
True or False

8. Which termite species termite's colonies are relatively small, with a few thousand members lacking the true worker caste, and there are often multiple colonies in the same structure?

9. Which termite species termite's colony consists of three castes: reproductives, soldiers and nymphs? Winged reproductive, or alates, are almost one-inch long and their color ranges from yellowish-brown to cinnamon-brown.

10. Which termite species does not build mud shelter tubes above the ground in order to reach wood?

Answers

1. True 2. Subterranean, 3. False, , 4. False, 5. True, 6. False, 7. True, 8. Drywood 9. Pacific dampwood 10. Desert Dampwood

Topic 3 - 1- Node Ant Section

Topic 3 - Section Focus: Because termite and ant treatments do over lap and ants and termites look very similar. You will learn the basics of one node ant identification and control techniques. At the end of this section, you will be able to understand and describe one-node ant control and elimination techniques. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Topic 3- Background: Carpenter ants are one of nature's most aggressive wood destroyers. Similar to termites, carpenter ants damage wood. Unlike termites however, carpenter ants **do not** eat wood for food. Carpenter ants only bore into wood to establish and/or enlarge their nest. They can do lots of damage to wood. Because of their ability to excavate wood and cause moderate amounts of localized damage, they are of economic importance to the pest control industry and to homeowners alike.

Ants are Wood Destroyers

BLACK CARPENTER ANT

As a termite pest controller, many of your calls for termites are not termites but ants and vise versa. Ants and termites are enemies are occasionally found together. We will master ant identification and control methods.

Ant Introduction

For some reason, ants, spiders and scorpions are high on the list for normal PCA work, because of this demand and for many calls are not ants but are termites, we will master the highly designed creature –the ant.

Ants form colonies that range in size from a few dozen predatory individuals living in small natural cavities to highly organized colonies that may occupy large territories and consist of millions of individuals. All ants like termites live in colonies, which consist of an egg-laying female (queen), short-lived males, and workers (sterile females). Larger colonies consist of various castes of sterile, wingless females, most of which are workers (ergates), as well as soldiers (dinergates) and other specialized groups. Nearly all ant colonies also have some fertile males called "drones" (aner) and one or more fertile females called "queens" (gynes).

The colonies are described as superorganisms because the ants appear to operate as a unified entity, collectively working together to support the colony just as termites.

Ants have colonized almost every landmass on Earth. The only places lacking indigenous ants are Antarctica and a few remote or inhospitable islands. Ants thrive in most ecosystems and may form 15–25% of the terrestrial animal biomass. Their success in so many environments has been attributed to their social organization and their ability to modify habitats, tap resources, and defend themselves.

Ant colonies have division of labor, communication between individuals, and an ability to solve complex problems. These parallels with human societies have long been an inspiration and subject of study. Some species are valued in their role as biological pest control agents. Their ability to exploit resources may bring ants into conflict with humans, however, as they can damage crops, invade buildings and for our study- destroy wood. Some species, such as the red imported fire ant (*Solenopsis invicta*), are regarded as invasive species, establishing themselves in areas where they have been introduced accidentally.

Trail Pheromone

The ants you see foraging in gardens or kitchens 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, 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. As with cockroaches, you should not underestimate the importance of good sanitation to eliminate food sources, although good sanitation may not control an ant infestation by itself.

Ants 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
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. We will go more into detail on these subjects later.

There are 455 different types of ants found in North America and around 8,000 worldwide that have been identified. They are black, brown or reddish-brown in color. Size varies from 1/16 of an inch long to 1 inch. The queens may from 1 to as long as 15 years! It is the carpenter ants that invade decaying areas of lumber in buildings hollowing them out and causing serious structural damage.

Stinging ants like the red imported fire ant (reddish color, 1/4 inch in length) and the southern fire ant (brownish-red with black of brown abdomen and head, 1/16 to 1/4 inch in length) inflict highly painful stings. They can be quite dangerous to babies and young children. All ant ants aside if you can tolerate some ants, they are fascinating to watch. They do aerate the soil and destroy some caterpillar pests.

Most ants eat a wide variety of foods, although some have specialized tastes. Fire ants feed on honeydew, sugars, proteins, oils, seeds, plants and insects. Pharaoh ants feed on sugars, proteins, oils and insects. Crazy ants like sugars, protein, and insects; carpenter ants prefer sugars and insects.

Hymenoptera Insect Order
Ants belong to the insect order Hymenoptera and are close relatives of bees and wasps. They are familiar insects that are easily recognized, especially in their common wingless adult forms, known as workers. However, winged forms of ants, which leave the nest in large numbers in warm weather to mate and establish new colonies, are often mistaken for winged termites, which also leave their nests to mate.

Ants and termites can be distinguished by three main characteristics:

- The ant’s body is constricted, giving it the appearance of having a thin waist; the termite’s body is not constricted.
- The ant’s hind wings are smaller than its front wings; the termite’s front and hind wings are about the same size. (Shortly after their flights, both ants and termites lose their wings, so wings may not always be present.)
- Winged female and worker ants have elbowed antennae; the termite’s antennae are not elbowed.

Key Words

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.

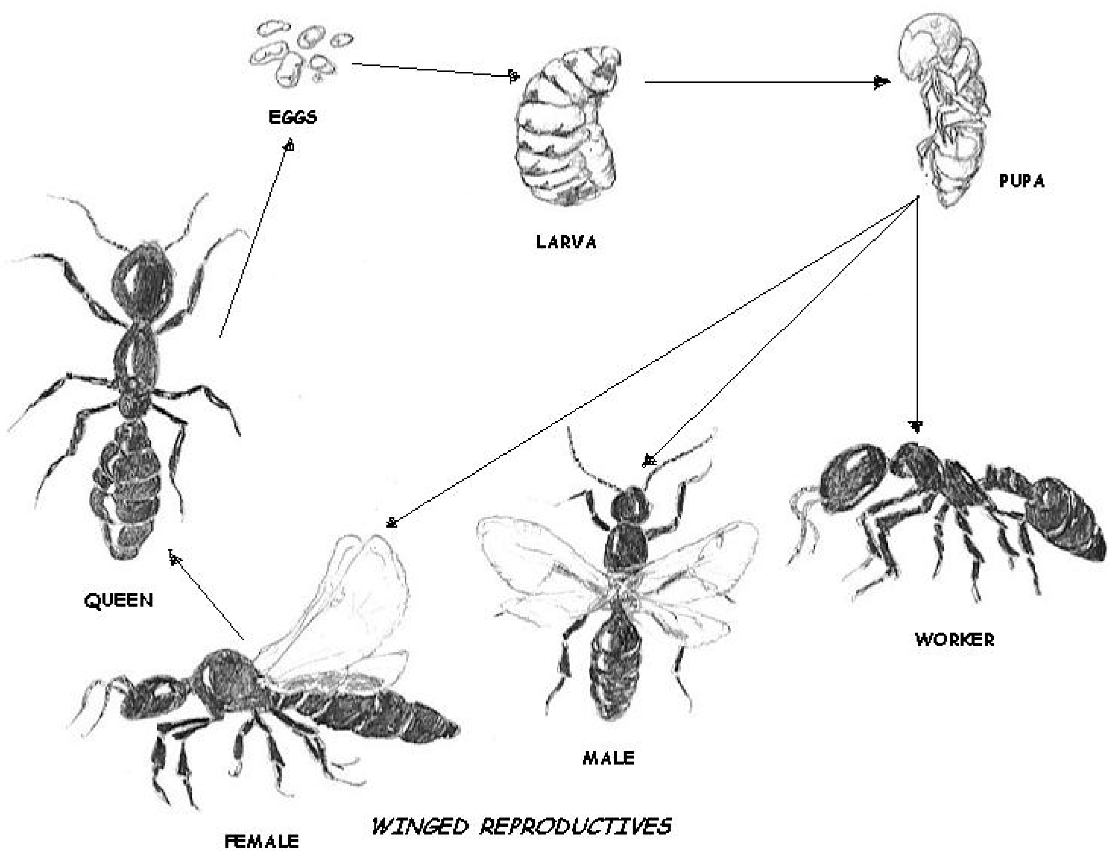
Pesticide: A chemical or other agent used to kill or otherwise control pests.

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.

Metamorphosis

In order to properly identify the pest, you will need to identify the insect in all stages of life. Ants undergo complete metamorphosis, passing through egg, larval, pupal, and adult stages. Larvae are immobile and wormlike and do not resemble adults. Ants, like many other hymenopterans, are social insects with duties divided among different types, or castes, of adult individuals.

Queens conduct the reproductive functions of a colony and are larger than other ants; they lay eggs and sometimes participate in the feeding and grooming of larvae. Female workers, who are sterile, gather food, feed and care for the larvae, build tunnels, and defend the colony; these workers make up the bulk of the colony. Males do not participate in colony activities; their sole purpose is to mate with the queens. Few in number, males are fed and cared for by workers.



ANT LIFE CYCLE DIAGRAM

Morphology

Definition: Morphology is the branch of biology that deals with the form of living organisms, and with relationships between their structures.

Ants are distinct in their morphology from other insects in having elbowed antennae, metapleural glands, and a strong constriction of their second abdominal segment into a node-like petiole. The head, mesosoma, and metasoma are the three distinct body segments. The petiole forms a narrow waist between their mesosoma (thorax plus the first abdominal segment, which is fused to it) and gaster (abdomen less the abdominal segments in the petiole). The petiole may be formed by one or two nodes (the second alone, or the second and third abdominal segments).

Like other insects, ants have an exoskeleton, an external covering that provides a protective casing around the body and a point of attachment for muscles, in contrast to the internal skeletons of humans and other vertebrates. Insects do not have lungs; oxygen and other gases, such as carbon dioxide, pass through their exoskeleton via tiny valves called spiracles. Insects also lack closed blood vessels; instead, they have a long, thin, perforated tube along the top of the body (called the "dorsal aorta") that functions like a heart, and pumps haemolymph toward the head, thus driving the circulation of the internal fluids. The nervous system consists of a ventral nerve cord that runs the length of the body, with several ganglia and branches along the way reaching into the extremities of the appendages.

Head

An ant's head contains many sensory organs. Like most insects, ants have compound eyes made from numerous tiny lenses attached together. Ant eyes are good for acute movement detection, but do not offer a high resolution image. They also have three small ocelli (simple eyes) on the top of the head that detect light levels and polarization.

Compared to vertebrates, most ants have poor-to-mediocre eyesight and a few subterranean species are completely blind. However, some ants, such as Australia's bulldog ant, have excellent vision and are capable of discriminating the distance and size of objects moving nearly a yard away.

Two antennae ("feelers") are attached to the head; these organs detect chemicals, air currents, and vibrations; they also are used to transmit and receive signals through touch. The head has two strong jaws, the mandibles, used to carry food, manipulate objects, construct nests, and for defense. In some species, a small pocket (infrabuccal chamber) inside the mouth stores food, so it may be passed to other ants or their larvae.

Mesosoma

Both the legs and wings of the ant are attached to the mesosoma ("thorax"). The legs terminate in a hooked claw which allows them to hook on and climb surfaces. Only reproductive ants, queens, and males, have wings. Queens shed their wings after the nuptial flight, leaving visible stubs, a distinguishing feature of queens. In a few species, wingless queens (ergatoids) and males occur.

Metasoma

The metasoma (the "abdomen") of the ant contains important internal organs, including those of the reproductive, respiratory (tracheae), and excretory systems. Workers of many species have their egg-laying structures modified into stingers that are used for subduing prey and defending their nests.

Polymorphism
Definition: Polymorphism in biology and zoology is the occurrence of two or more clearly different morphs or forms, also referred to as alternative phenotypes, in the population of a species. In order to be classified as such, morphs must occupy the same habitat at the same time and belong to a panmictic population (one with random mating).

In the colonies of a few ant species, there are physical castes—workers in distinct size-classes, called minor, median, and major ergates. Often, the larger ants have disproportionately larger heads, and correspondingly stronger mandibles. These are known as macrergates while smaller workers are known as micrergates. Although formally known as dinergates, such individuals are sometimes called "soldier" ants because their stronger mandibles make them more effective in fighting, although they still are workers and their "duties" typically do not vary greatly from the minor or median workers. In a few species, the median workers are absent, creating a sharp divide between the minors and majors. Weaver ants, for example, have a distinct bimodal size distribution. Some other species show continuous variation in the size of workers.

Carebara
Carebara is a genus of ants in the subfamily Myrmicinae. It is one of the largest myrmicine genera with more than 174 species distributed worldwide in the tropics and the Afrotropical region. Many of them are very tiny cryptic soil and leaf litter inhabitants. They nest in rotten wood to which the bark is still adherent in the Afrotropical region, or may be lestobiotic nesting near other ant species. Some species are known to exist parasitically within termite nests. Little is known about the biology of the species. However, they are notable for the vast difference in size between queens and workers.

The smallest and largest workers in Pheidologeton (a sub category in Carebara) diversus show nearly a 500-fold difference in their dry-weights. Workers cannot mate; however, because of the haplodiploid sex-determination system in ants, workers of a number of species can lay unfertilized eggs that become fully fertile, haploid males. The role of workers may change with their age and in some species, such as honeypot ants, young workers are fed until their gasters are distended, and act as living food storage vessels. These food storage workers are called repletes. For instance, these replete workers develop in the North American honeypot ant Myrmecocystus mexicanus.

Usually the largest workers in the colony develop into repletes; and, if repletes are removed from the colony, other workers become repletes, demonstrating the flexibility of this particular polymorphism. This polymorphism in morphology and behavior of workers initially was thought to be determined by environmental factors such as nutrition and hormones that led to different developmental paths; however, genetic differences between worker castes have been noted in Acromyrmex sp.

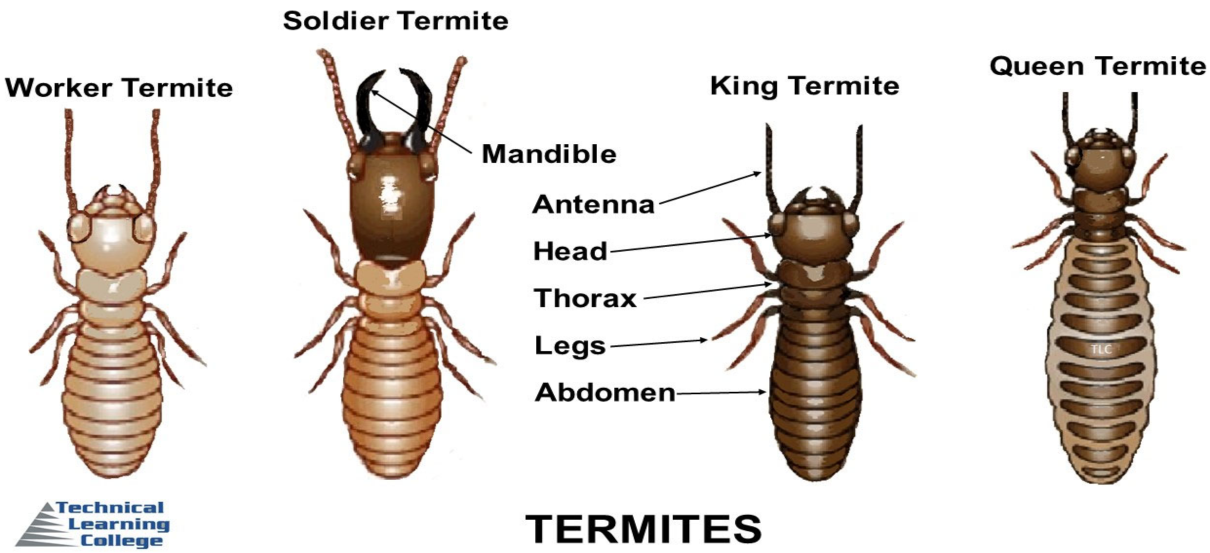
These polymorphisms are caused by relatively small genetic changes; differences in a single gene of Solenopsis invicta can decide whether the colony will have single or multiple queens.

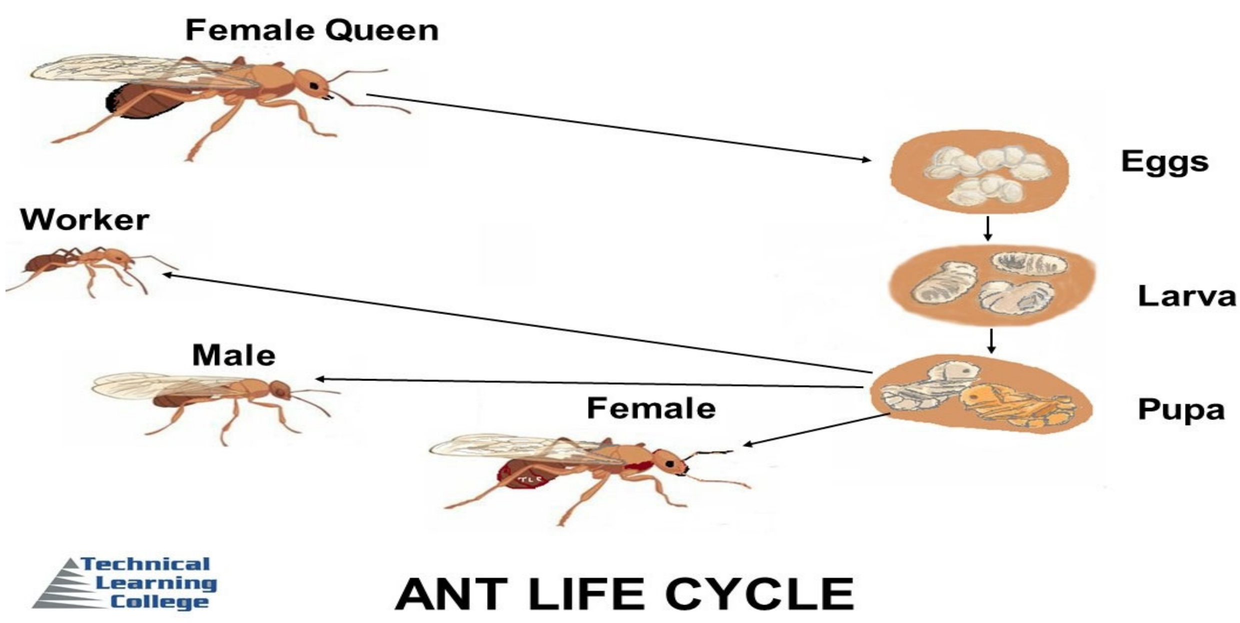
The Australian jack jumper ant (Myrmecia pilosula) has only a single pair of chromosomes (with the males having just one chromosome as they are haploid), the lowest number known for any animal, making it an interesting subject for studies in the genetics and developmental biology of social insects.

Termites Verses Ants Identification

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 Introduction

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 general procedures:

First, properly identify the pest**.**

Second, 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. Place traps.

Third, 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 bring the insecticide back to the nest and to the queen 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.

House Ants

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*.

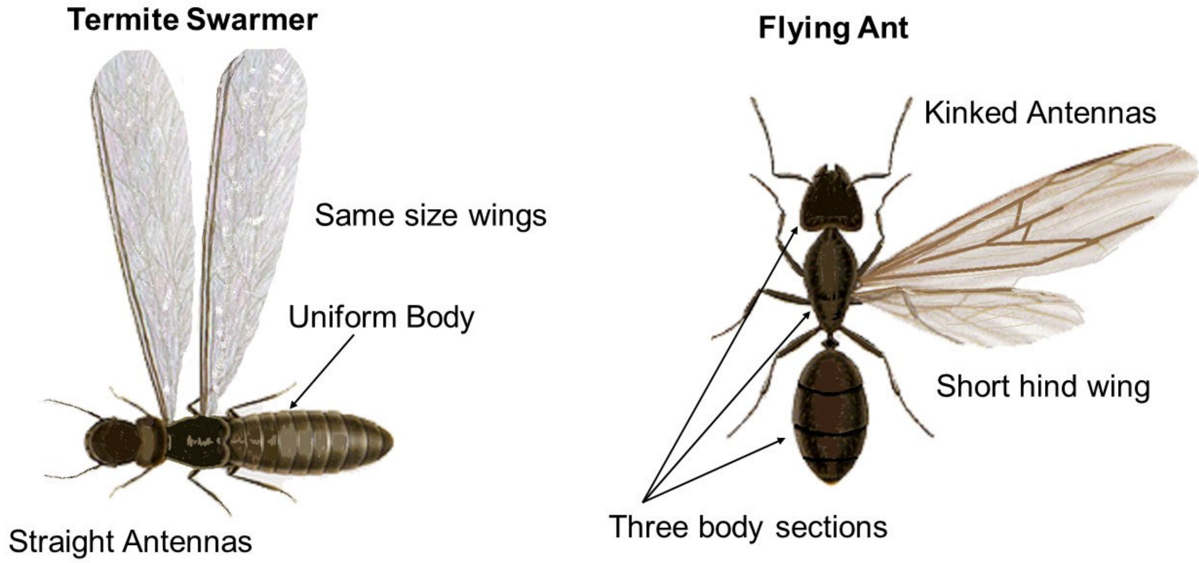
All of these ants may infest food products. Spraying a residual insecticide to control foraging workers may provide only short-term control. Even when over 99 percent of foraging workers are killed by insecticide sprays, the colony may rebuild to its original numbers. Location and total destruction of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

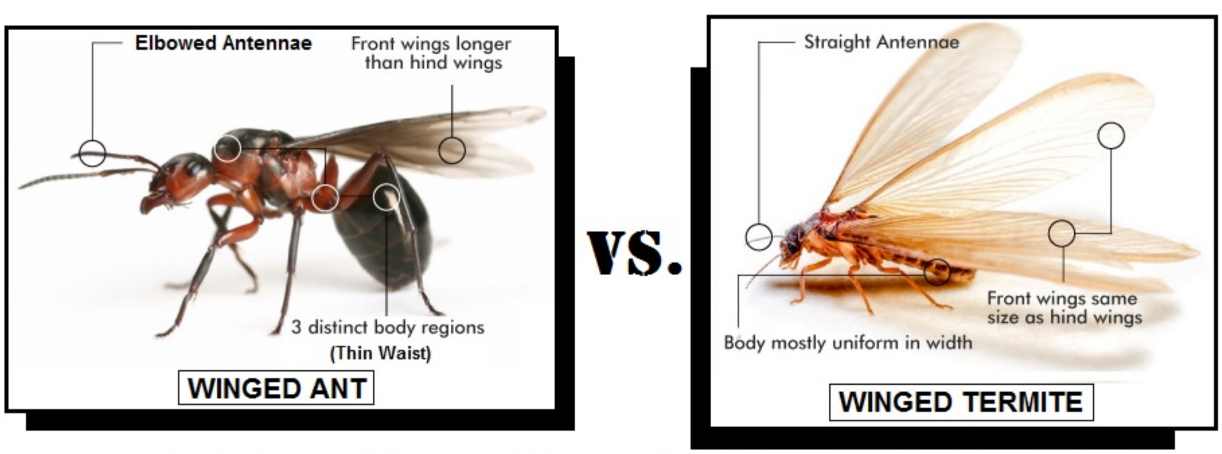
IPM Control Program

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. We will cover this in detail later in the course.

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, and 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.

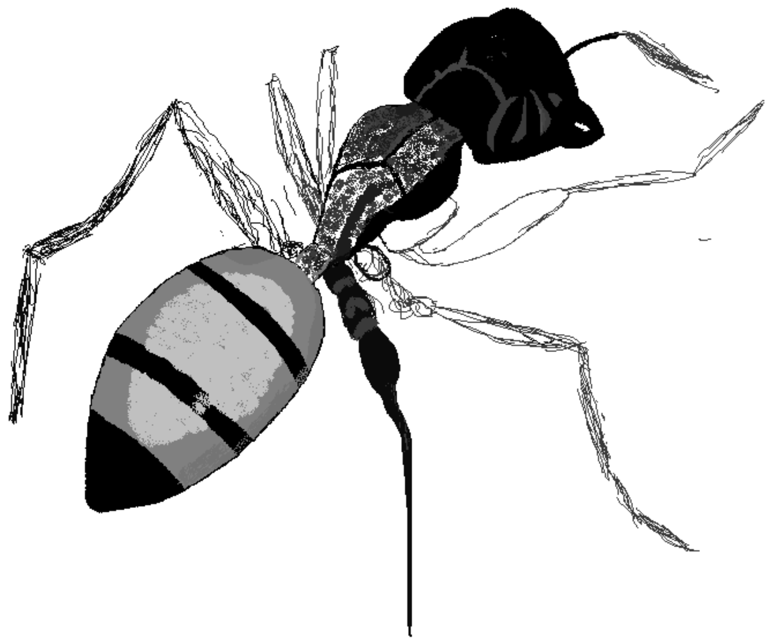


SWARMER TERMITE & FLYING ANT



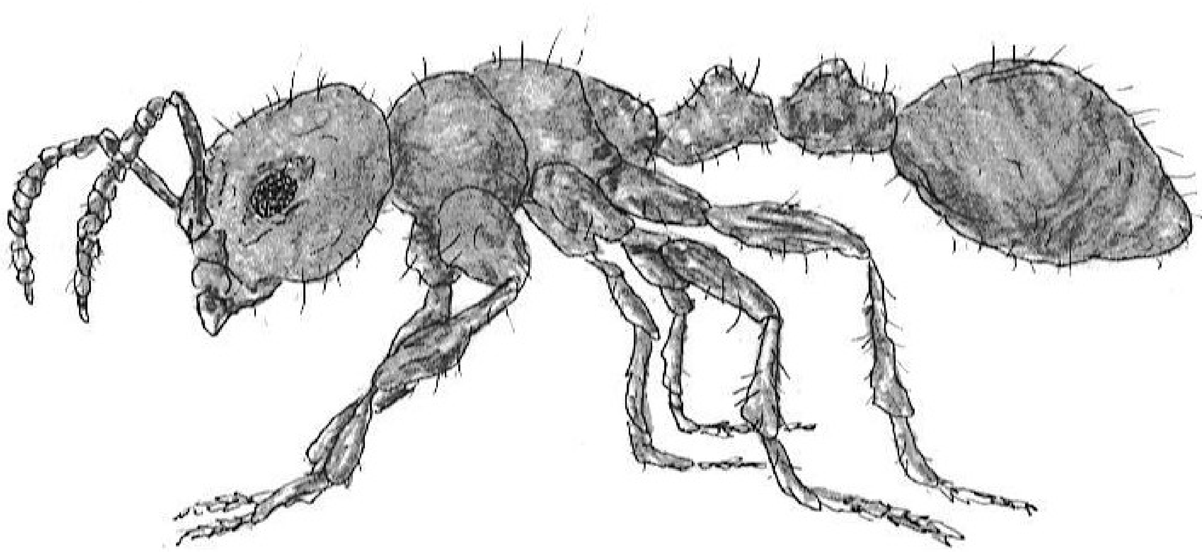
WINGED TERMITE / WINGED ANT COMPARISON

One Node Ants and Identification Section

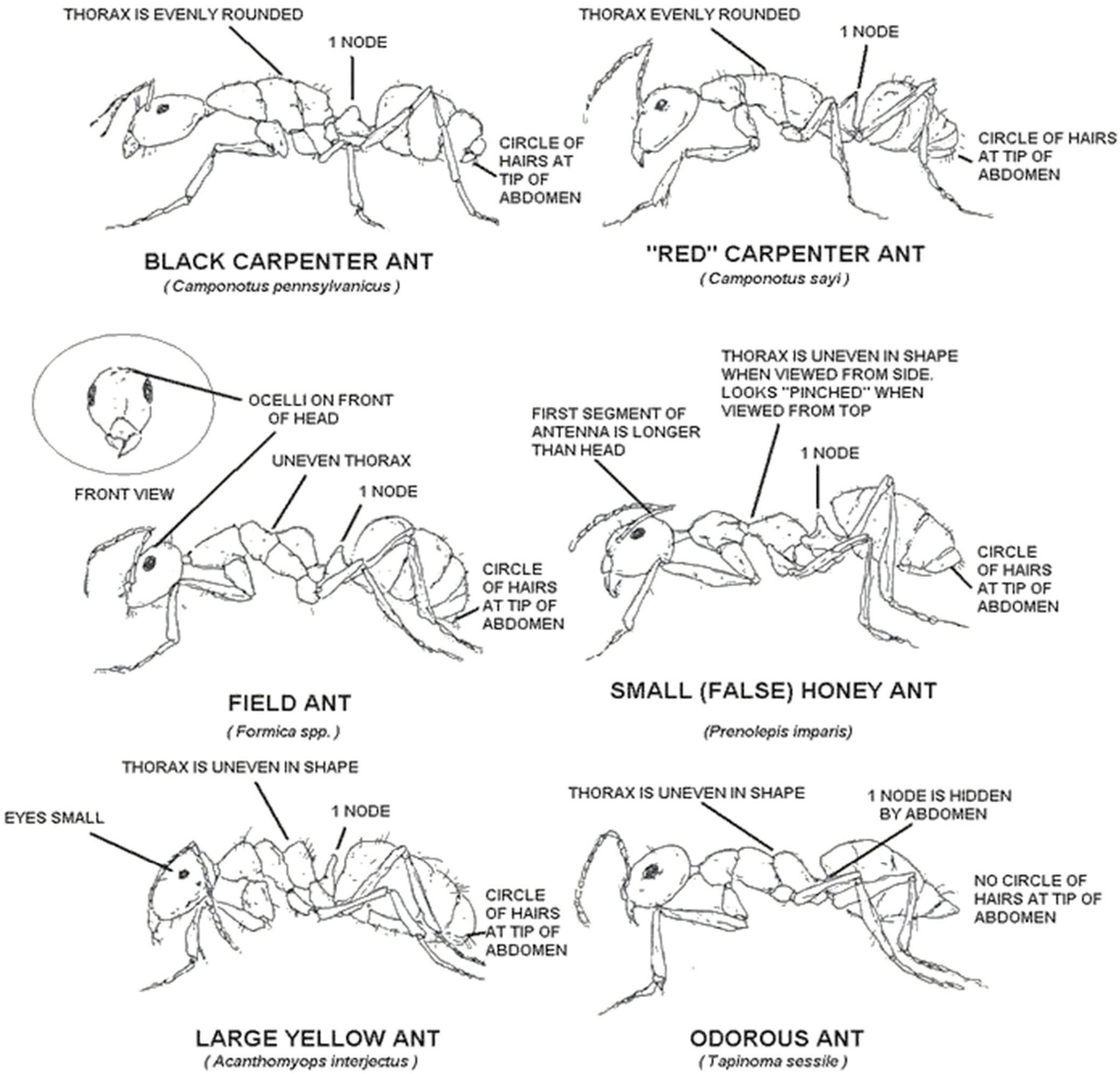


CARPENTER ANT

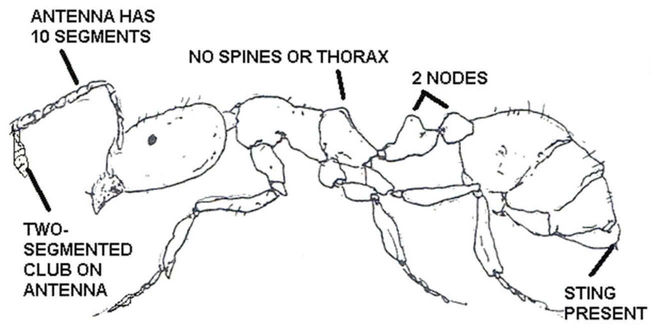
Top diagram, Carpenter Ant; below, Odorous House Ant or Piss Ant. One node verses two nodes.



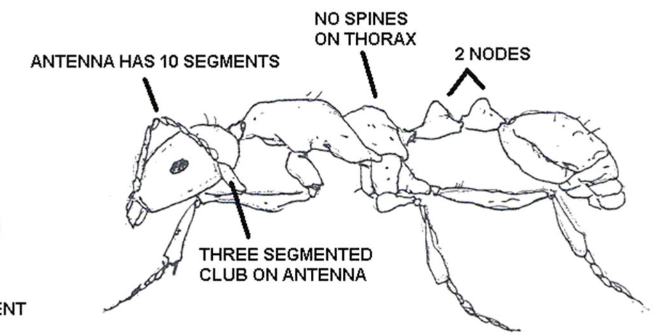
ODOROUS HOUSE ANT



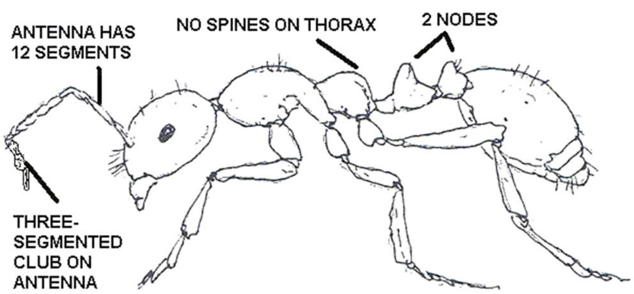
ANT IDENTIFICATION KEY
1- NODE ANTS



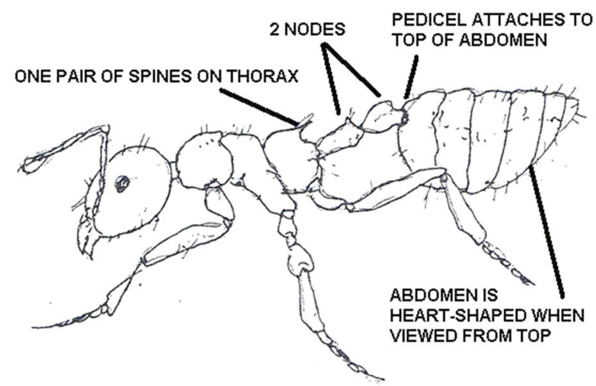
THIEF ANT
(Solenopsis molesta)



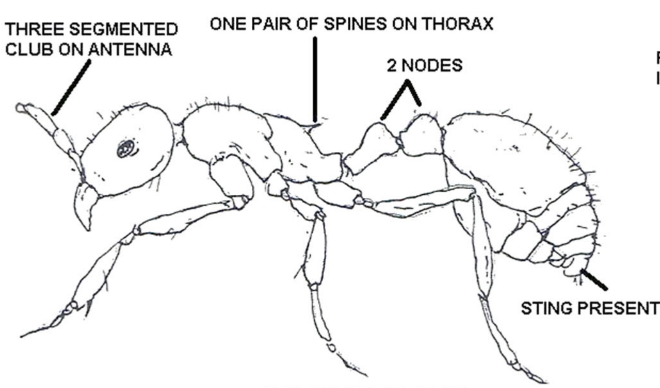
PHARAOH ANT
(Monomorium pharaonis)



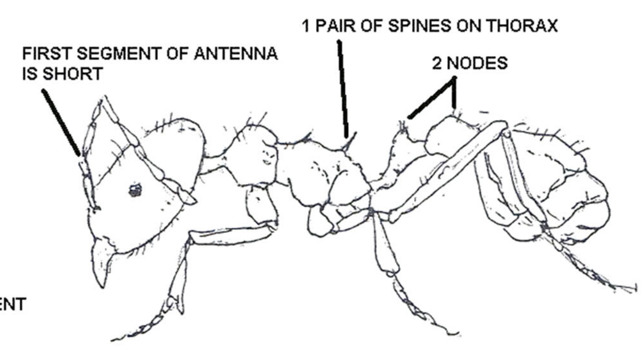
LITTLE BLACK ANT
(Monomorium minimum)



ACROBAT ANT
(Cremastogaster lineolata)

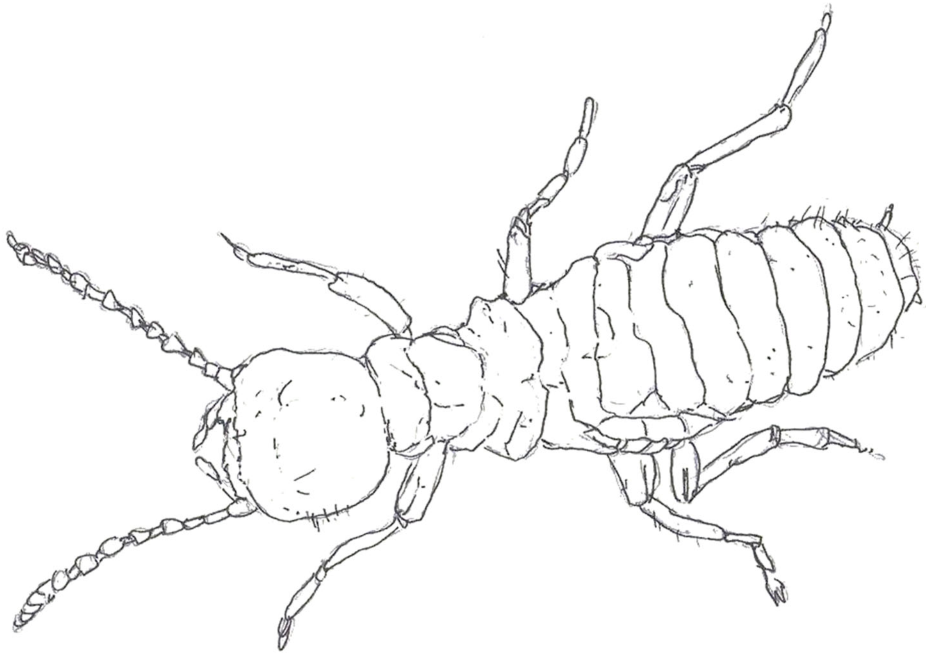


PAVEMENT ANT
(Pheidole spp.)

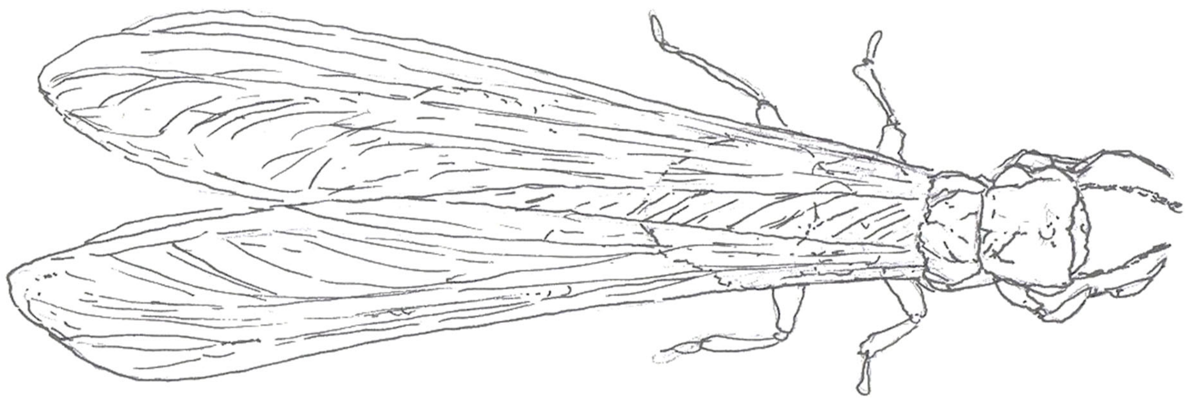


BIG-HEADED ANT
(Pheidole spp.)

ANT IDENTIFICATION KEY
2- NODE ANTS



WORKER TERMITE

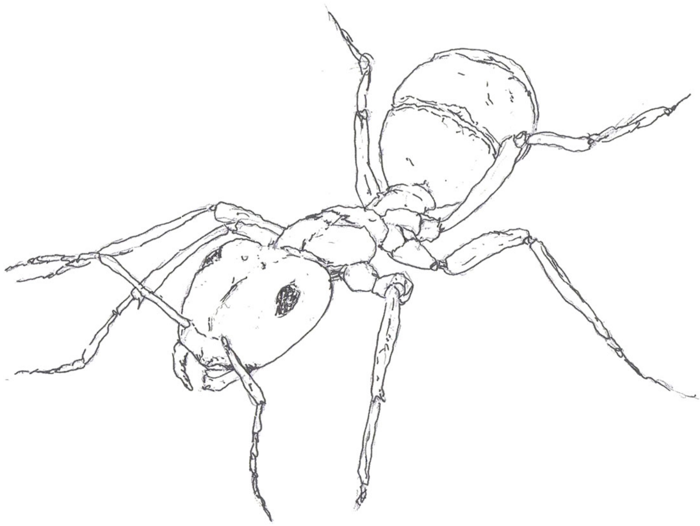


WINGED TERMITE

Ant Classification

We would like to classify ants as big or small but this is difficult, so we will classify as one-node verses two-nodes and hidden nodes. Effective management approaches vary with ant species. Use behavioral characteristics such as food and nesting preferences along with physical characteristics to identify ants. A first step in identifying ants is to use a magnifier to determine if they have one or two nodes at the petiole of their abdomen. Locate the petiole, the first portion of the abdomen, and count the number of nodes present.

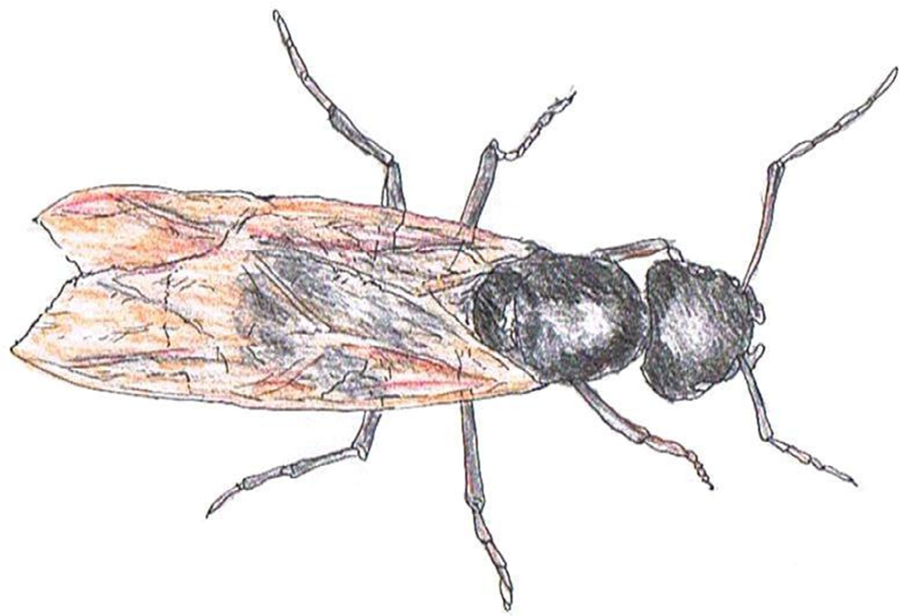
One-Node Ants



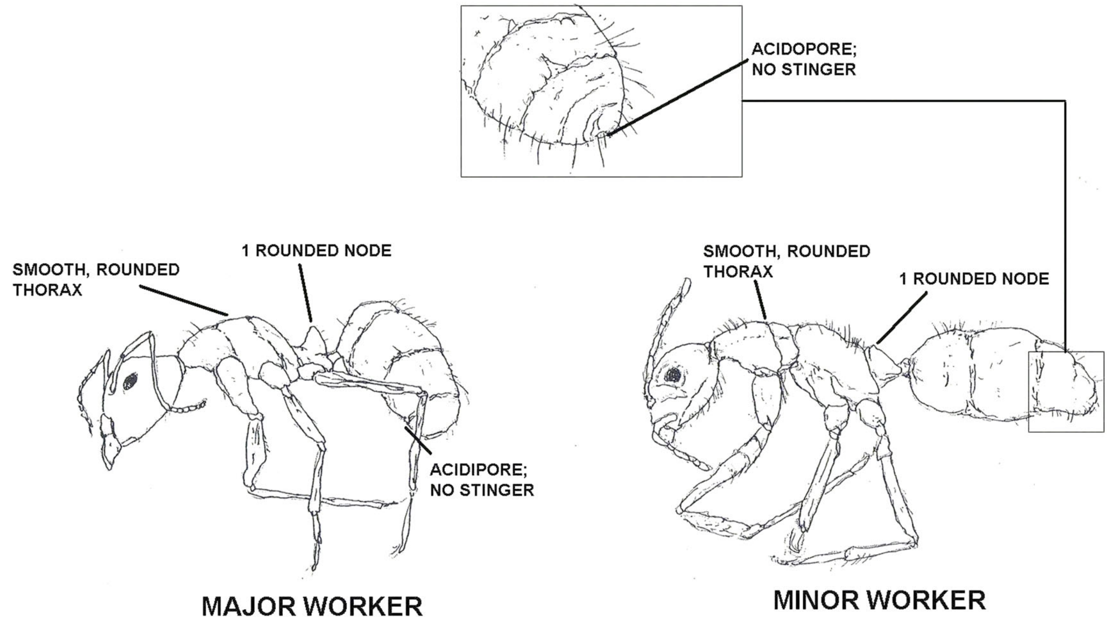
ARGENTINE ANT

Argentine ant (Linepithema humile)
Food: sweets, sometimes proteins. **Nest**: outdoors in shallow mounds. 1/8 inch, dull brown.

Crazy Ants ***Various species from Yellow to Raspberry***
Crazy ants vary from red-brown to grayish, and even black in color. Crazy ants are very easy to identify due to their fast, excited movements. Node is often hidden or difficult to see.
Range from 1/12-inch to 1/8-inch in length. Various colors.

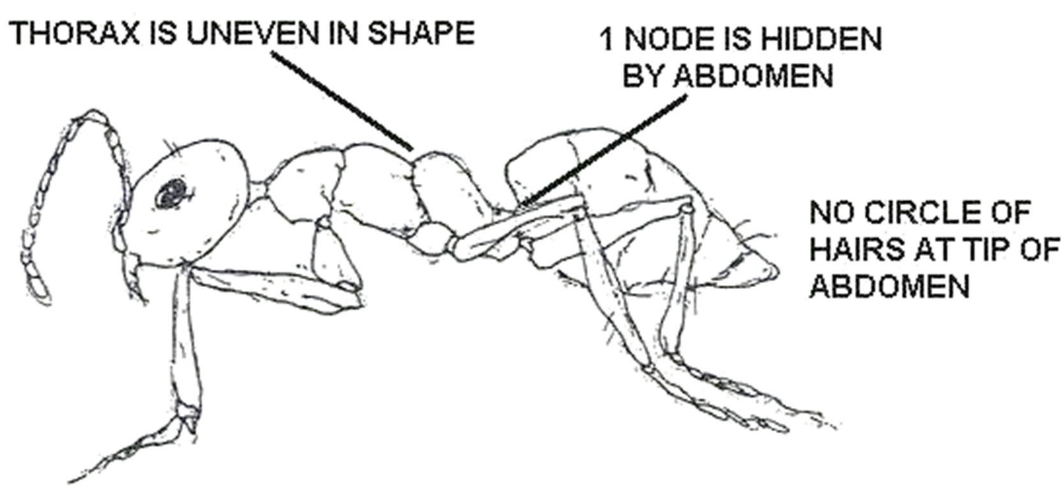


CARPENTER ANT QUEEN



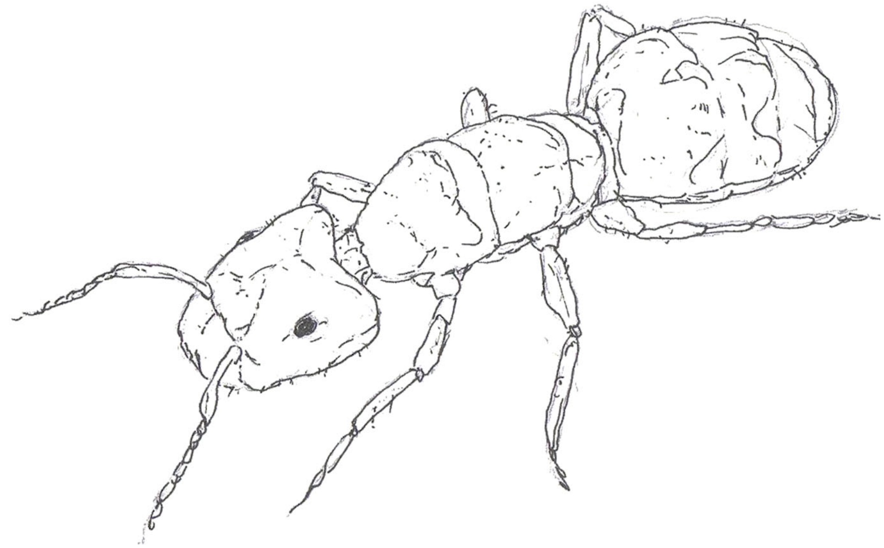
CARPENTER ANT

Carpenter Ant (Camponotus spp.)
Food: Sweets. **Nest**: in tree stumps, firewood, fence posts, hollow doors or window frames; deposit sawdust like frass outside of nests. Large, 1/4 to 1/2 inch, black or bicolored red or black.



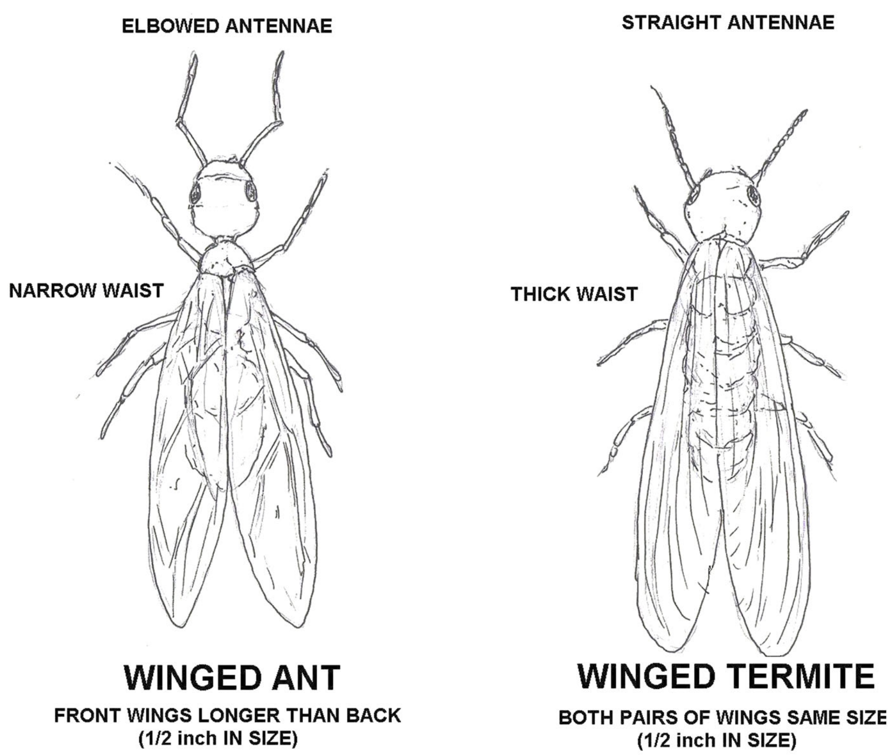
ODOROUS ANT (TAPINOMA SESSILE)

Odorous house ant (Tapinoma sessile)
Food: sweets, sometimes proteins. **Nest**: in shallow mounds in soil or debris, or indoors in wall voids, around water pipes or heaters. 1/8 inch, dark brown to shiny black; very strong odor when crushed.



VELVETY TREE ANT

Velvety tree ant (Liometopum occidentale)
Food: sweets and insects. **Nest**: in dead wood such as old tree limbs, stumps, and logs.
1/8 to 1/4 inch, brownish-black head, red thorax, and velvety black abdomen; very distinct odor when crushed



Acacia Tree Ants, often confused with RIFA– 2 Node Ant

Bullhorn Acacia is best known for its symbiotic relationship with a species of Pseudomyrmex ant (*Pseudomyrmex ferruginea*) that lives in its hollowed-out thorns. Unlike other acacias, Bullhorn acacias are deficient in the bitter alkaloids usually located in the leaves that defend against ravaging insects and animals. Bullhorn acacia ants fulfill that role.

The ants act as a defense mechanism for the tree, protecting it against harmful insects, animals or humans that may come into contact with it.

These incredible ants live in the hollowed-out thorns for which the tree is named. In return, the tree supplies the ants with protein-lipid nodules called Beltian bodies from its leaflet tips and carbohydrate-rich nectar from glands on its leaf stalk.

These Beltian bodies have no known function other than to provide food for the symbiotic ants. The aggressive ants release an alarm pheromone and rush out of their thorn "barracks" in great numbers.

According to Daniel Janzen, livestock can apparently smell the pheromone and avoid these acacias day and night. Getting stung in the mouth and tongue is an effective deterrent to browsing on the tender foliage. In addition to protecting A. conigera from leaf-cutting ants and other unwanted herbivores, the ants also clear away invasive seedlings around the base of the tree that might overgrow it and block out vital sunlight.

Antlions –Enemy of Ants

Antlions are a group of insects in the family Myrmeleontidae (sometimes misspelled as "Myrmeleonidae"). The most well-known genus is Myrmeleo. There are about 2,000 species. Strictly speaking, the term "antlion" applies to the larval form of the members of this family, but while several languages have their own terms for the adult, there is no widely used word for them in English. Very rarely, the adults are called "antlion lacewings".

The antlion larva is often called "doodlebug" in North America because of the odd winding, spiraling trails it leaves in the sand while looking for a good location to build its trap, as these trails look like someone has doodled in the sand

An average-sized larva digs a pit about 2 inches deep and 3 inches wide at the edge. This behavior has also been observed in a family of flies, the Vermileonidae, whose larvae dig the same sort of pit to feed on ants. Having marked out the chosen site by a circular groove, the antlion larva starts to crawl backwards, using its abdomen as a plough to shovel up the soil. By the aid of one front leg it places consecutive heaps of loosened particles upon its head, then with a smart jerk throws each little pile clear of the scene of operations.

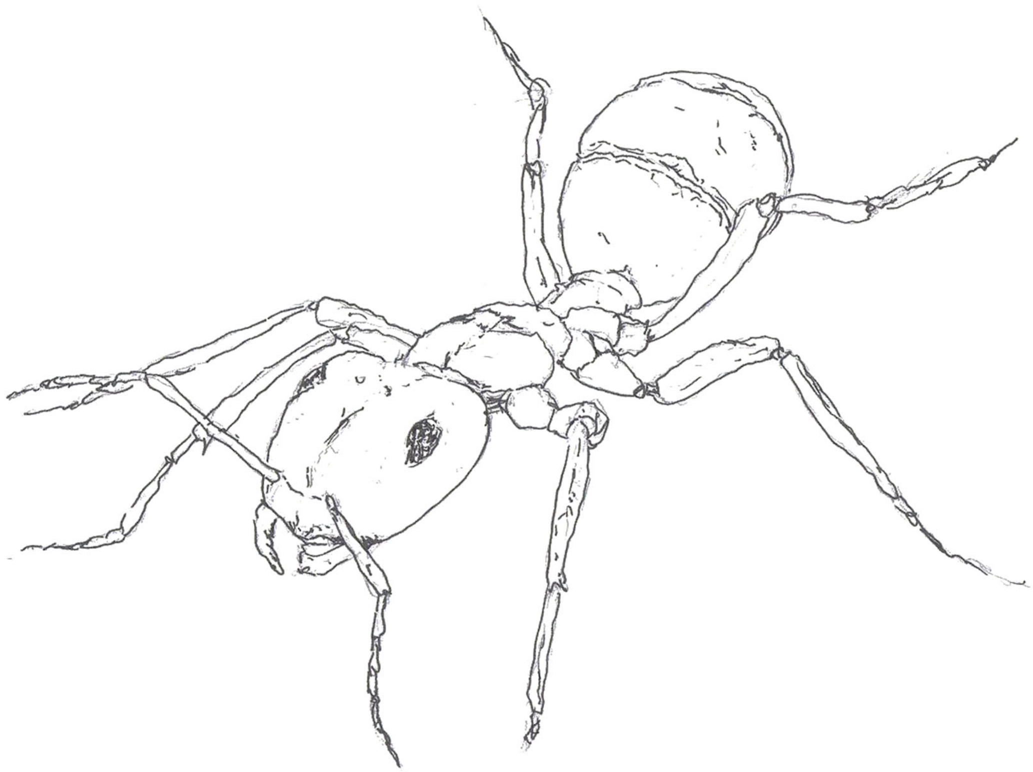
Proceeding thus it gradually works its way from the circumference towards the center. As it slowly moves round and round, the pit gradually gets deeper and deeper, until the slope angle reaches the critical angle of repose (that is, the steepest angle the sand can maintain, where it is on the verge of collapse from slight disturbance). When the pit is completed, the larva settles down at the bottom, buried in the soil with only the jaws projecting above the surface, often in a wide-opened position on either side of the very tip of the cone.

Since the sides of the pit consist of loose sand at its angle of repose, they afford an insecure foothold to any small insects that inadvertently venture over the edge, such as ants. Slipping to the bottom, the prey is immediately seized by the lurking antlion; or if it attempts to scramble up the treacherous walls of the pit, it is speedily checked in its efforts and brought down by showers of loose sand which are thrown at it from below by the larva. By throwing up loose sand from the bottom of the pit, the larva also undermines the sides of the pit, causing them to collapse and bring the prey with them. Thus it does not matter whether the larva actually strikes the prey with the sand showers.

Antlion larvae are capable of capturing and killing a variety of insects and other arthropods, and can even subdue small spiders. The projections in the jaws of the larva are hollow and through this the larva will suck the fluids out of its victim. After the contents are consumed, the dry carcass is flicked out of the pit. The larva readies the pit once again by throwing out collapsed material from the center, steepening the pit walls to the angle of repose.

Antlions are especially abundant in soft sand beneath trees or under overhanging rocks. Apparently the larvae prefer dry places that are protected from the rain. Eventually the larva attains its maximum size and undergoes metamorphosis. The entire length of time from egg-laying to adulthood may take two or three years due to the uncertainty and irregular nature of its food supply. When it first hatches, the tiny larva specializes in very small insects, but as it grows larger, it constructs larger pits and thus catches larger prey.

Argentine Ant - 1 Node Ant



ARGENTINE ANT

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. However, it is very common in California. More about this ant later in this course.

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 super colonies. 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 ant's 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, and 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.

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. 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.

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.

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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, and plastic vial caps and/or drafting (masking) tape.

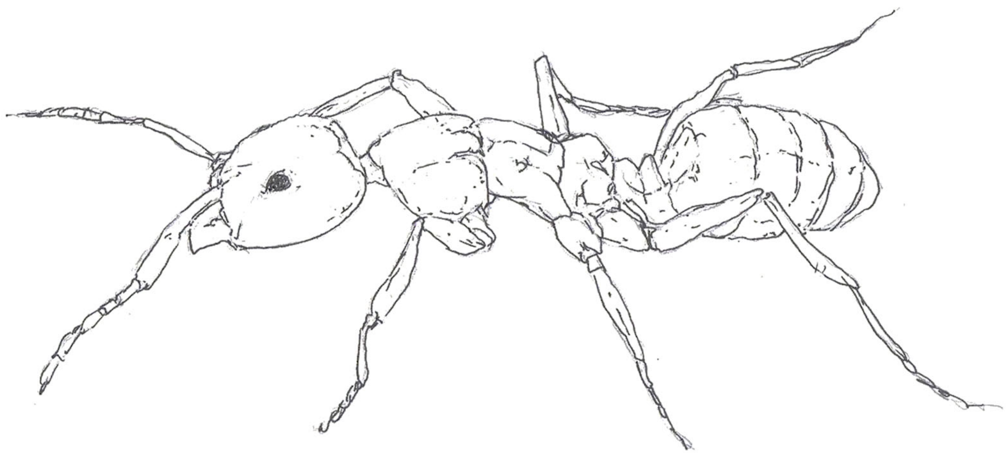
Placement can be made on the rear lip of kitchen counters, at plumbing pipe-wall junctions, on window sills, behind wall electrical outlets, above door frames, etc., in less accessible areas of pets or young children. There may be increased or new ant feeding activity during the early part of the baiting 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 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)).

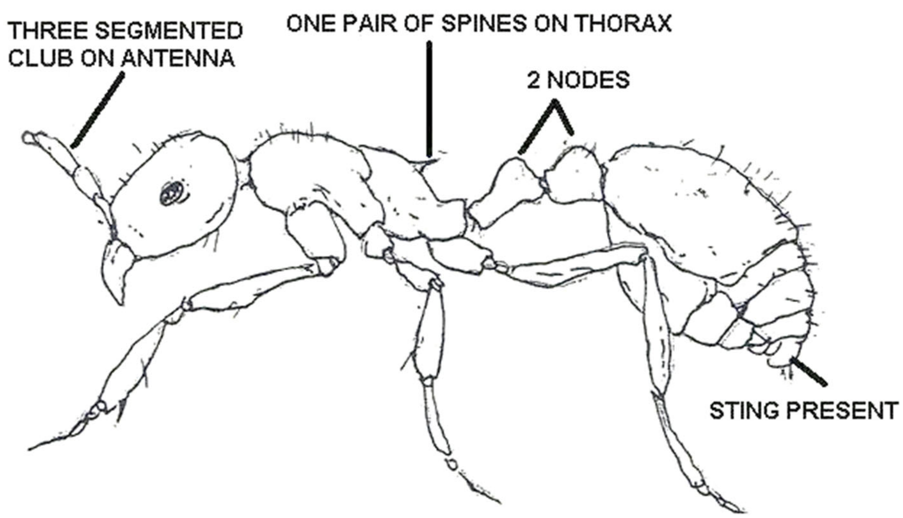
After bait stations are placed, one will see ants trailing to and from these bait stations. Do not spray or disturb the ants or bait stations. Ants must be allowed to carry the bait back into their nest where the active ingredient in the bait will eliminate the colony.

These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded.

No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

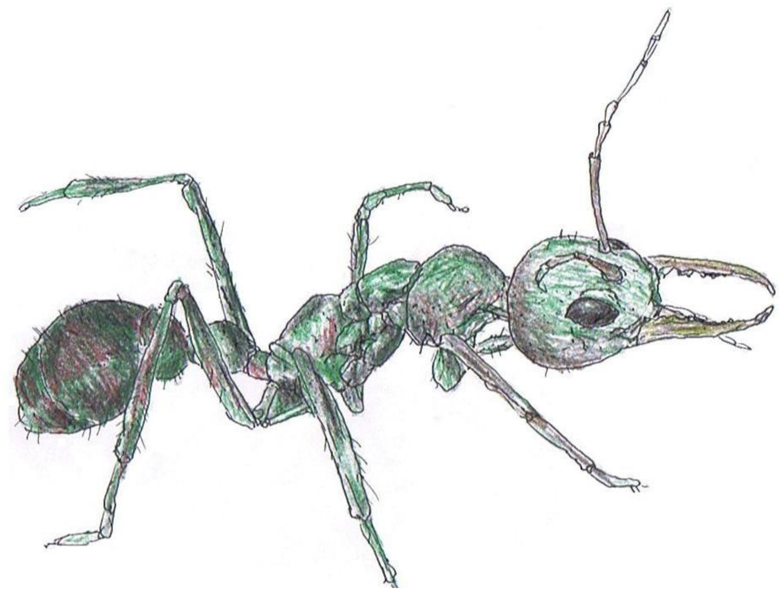


ARGENTINE ANT



PAVEMENT ANT (PHEIDOLE SPP.)

Bull or Bull Dog Ant - 1 Node Ant



BULL ANT

Myrmecia, often called bulldog ants, bull ants, inch ants, sergeant ants, jumper ants or jack-jumpers (although jack jumper only applies to members of the M. pilosula species group), is a genus of ants. Bull ants can grow to over 40 mm (1.6 in) in length, with the smallest species 15 mm (0.59 in) long.

Bull ants eat small insects, honeydew (a sweet, sticky liquid found on leaves, deposited from various insects), seeds, fruit, fungi, gums, and nectar. The adult ants mainly eat nectar and honeydew, but the ant larvae are carnivores that eat small insects brought back to them by hunting worker ants. The workers can also regurgitate food back in the nest so other ants can consume it. Foes of bull ants are the black ants, which despite being much smaller, use their much greater numbers to overwhelm bull ant colonies.

Bull ants are fierce little creatures. The sting of a bull ant is not barbed and does not remain in the victim, unlike the sting of a bee. The bull ant can sting again and again repeating its dose. The bull ant's stinger is located in the abdomen. The jaws of the bull ant workers are quite gentle unlike many other ants. They feed on other insects and things such as honeydew from scale insects. The queen bull ant leaves the nest at night to forage and supplement the food supply of her progeny, the baby bull ants.

These ants have a red head and thorax but the abdomen are black. They make their nests underground and have quite extensive tunnel systems. You can usually identify a bull ant's nest by the mound of dirt with rather large opening, sometimes several openings at the top. The dirt is loosely scattered around the mound and two or three bull ant guards (soldiers) can often be seen in the immediate area keeping a sharp eye out for any possible intruders.

Formicidae (order Hymenoptera)
There are about 8000 species of ants in the insect family Formicidae (order Hymenoptera). Ants live just about all over the world but they generally prefer warmer climates. They range from as little as 2mm to 25mm in size.

Ants live eight to ten weeks passing through a four-stage life cycle, - egg - larva - pupa and adult. The workers are the females and do the labor of the nest while the larger ones are the soldiers, defending the colony. At certain times of the year many ant species produce winged males and queens. These fly into the air where they mate (with the male dying soon afterwards). The fertilized queen ant then establishes a new nest and spends the rest of her life laying eggs for her colony.

In general, ant baits can be found as:
- Granules for broadcast
- Liquids
- Gels
- Ready-to-use, tamper resistant containers

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.

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

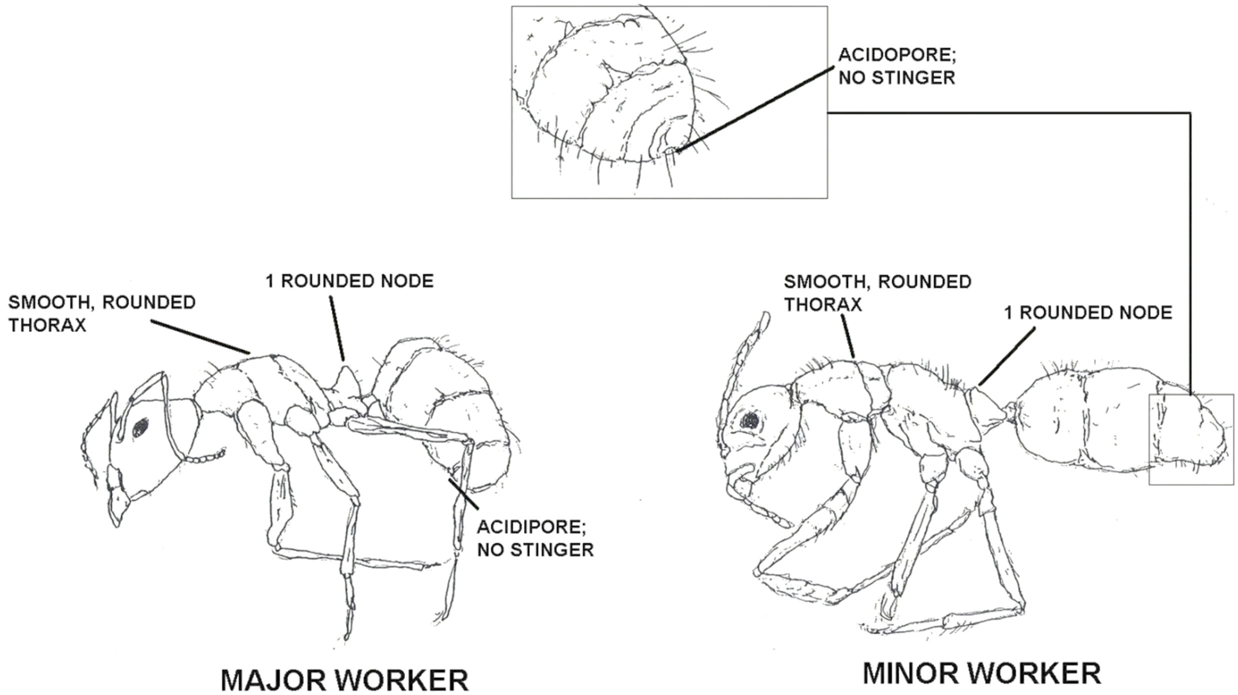
The Recommended Products for the Sugar Eating Cycle Would Be:
- Maxforce Ant Killer Bait Gel
- Uncle Albert's Gel Bait
- Revenge Liquid Ant Bait

- 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.

Carpenter Ants - 1 Node ant – *Wood Destroyer*



CARPENTER ANT DIAGRAM

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

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.

Carpenter ants nest in moist wood including rotting trees, tree roots, tree stumps, and logs or boards lying on or buried in the ground. They can also nest in moist or decayed wood inside buildings. Wood decay may be caused by exposure to leaks, condensation, or poor air circulation. Nests have been found behind bathroom tiles; around tubs, sinks, showers, and dishwashers; under roofing, in attic beams, and under subfloor insulation; and in hollow spaces such as doors, curtain rods, and wall voids. Carpenter ants may also nest in foam insulation.

Carpenter Ant Colony
A parent carpenter ant colony sometimes establishes one or more satellite nests in nearby indoor or outdoor sites. Satellite nests are composed of workers, pupae, and mature larvae. A satellite nest does not require moisture because the workers do not tend eggs (the eggs would dry out without sufficient humidity). For this reason, satellite nests can be found in relatively dry locations, such as insulation, hollow doors, and sound wood.

The workers of satellite colonies move readily between their nest and the parent colony. In late summer, winged reproductives (i.e. queens and males) may emerge from pupae transported into satellite colonies. They may appear in structures in late winter and early spring as they swarm from a satellite nest. In order to eliminate carpenter ants nesting indoors, you need to locate and destroy their nest.

The nest may be located by careful and patient observations of worker ants, especially between sunset and midnight during spring and summer months when carpenter ants are most active. To follow carpenter ants without startling them, use a flashlight with a red film over the lens—ants cannot see red light. You can increase your chances of following workers to their nest by setting out food that is attractive to carpenter ants. Place food in areas where you find workers.

Many foods are attractive to carpenter ants, including honey or other sweet foods. During spring, carpenter ants are particularly attracted to protein sources, such as tuna packed in water. (Carpenter ants are not attracted to tuna packed in oil.)

Set out small pieces of tuna for the ants to take back to their nest. It is easier to follow the ants when they are carrying food. With patience and perseverance, you can follow the ants back to their nest.

Other signs that indicate an active nest is nearby include small piles of coarse sawdust or wood shavings, consistent indoor sightings of large numbers of worker ants, i.e. 20 or more and large numbers of winged ants indoors. Carpenter ants typically swarm from late winter through spring. Also pay attention to areas where steady moisture is or has been a problem; firewood stored in an attached garage, next to the foundation, along an outside wall, or in a basement; areas around the plumbing or vent entrances; and trees with branches overhanging the house. These are possible sources of carpenter ant nests.

Sound Detection
Sound detection may be helpful in locating a nest. An active colony may make a dry, rustling sound that becomes louder if the colony is disturbed. This sound, thought to be a form of communication, is made with the mandibles (jaws) and is not related to wood chewing. When trying to detect carpenter ants, tap the suspected area and then press an ear to the surface in order to hear any sound. If one nest is found, watch for evidence of additional nests. More than one nest may be present in a structure.

Carpenter Ant Control Section
The best method to control carpenter ants is to locate and destroy the nest, replace damaged or decayed wood, and, if they exist, eliminate moisture problems. Eliminating a carpenter ant nest is a difficult and challenging task. It is possible for a homeowner to control carpenter ants on their own efforts. However, in most cases, control should be performed by an experienced pest control applicator like yourself. Only we have the experience and a wider array of products to effectively control a carpenter ant problem. Homeowners can still play a crucial role in control programs by providing information to us, such as when, where, and how many ants were seen.

Indoors
Nests are often concealed in wall voids, ceilings, subfloors, attics, or hollow doors. It is usually necessary for a professional pest control applicator to drill small (about 1/8 inch) holes and apply an insecticidal dust into the nest area. It is best to determine the nest's location as specifically as possible. Control should not be applied randomly through the home. There are no insecticides available to the public that are labeled for this type of application.

If it is difficult to locate the nest, an insecticidal dust can be applied into wall voids through electrical outlets. Carpenter ants commonly travel along electrical wiring and are likely to encounter the insecticides. This method works more slowly than a direct treatment into the nest. Boric acid is available to homeowners to treat wall voids through electrical outlets. CAUTION: Use extreme care around electrical wiring and take all necessary steps to avoid accidental electric shocks.

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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.

Crazy Ant - 1 Node 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.

YELLOW CRAZY ANT

The crazy ant, P. longicornis may in some cases create massive, but localized numbers. These species look similar, but have marked differences. Paratrechina longicornis antennae and legs are significantly longer than that of N. sp. nr. pubens. Paratrechina longicornis thorax is extended in length considerably, compared to that of the Nylanderia species. Although the use of color as an identification tool is not to be relied upon, the crazy ant is often jet black in color, especially when compared to the typically reddish-brown of N. sp. nr. pubens.

Colonies of crazy ants are moderate to very populous. The colonies may raise sexuals at any time of the year in warmer regions, but in the seasonal climate of north Florida, alate production is apparently limited to the warm rainy months of May through September (Trager 1984). On warm, humid evenings, large numbers of males gather outside nest entrances and may mill about excitedly. Workers patrol vegetation and other structures nearby. Periodically, a dealate (wingless) queen emerges. Mating was not observed, but Trager (1984) suggested that it occurred in such groupings around the nest entrance. Wings of queens are removed while still callow and males were never observed to fly or use their wings in any way. However, in several cases it has been observed that males frequently appear at lights (Trager 1984).

Pest Status

The crazy ant has achieved pest status across the United States. It has been found on top floors of large apartment buildings in New York, hotels and flats in Boston and in hotel kitchens in San Francisco, California. Marlatt (1930) observed that the crazy ant is a pest in Florida and the Gulf States. As an example, in 1977, modular units were being used as temporary schoolrooms by a North Lauderdale elementary school. The principal reported that the units were so inundated by the ant that students were constantly in a state of turmoil. The invasion reached such proportions that the students' sack lunches were kept in closed plastic bags placed on tables, with each table leg sitting in a pan of water as a barrier to the ant.

It can be a significant agricultural pest as it assists in the distribution and/or protection of phloem-feeding Hemiptera, such as mealybugs, scale insects, and plant aphids (Wetterer 2008).

Foraging and Feeding
Workers are omnivorous, feeding on live and dead insects, seeds, honeydew, fruits, plant exudates, and many household foods. The crazy ant thrives in places such as gasoline stations, convenience stores, and sidewalk cafes where workers may be seen transporting crumbs and insects attracted to lights. They apparently have a seasonal preference for a high-protein diet, and during the summer months may refuse honey or sugar baits. They are attracted to honeydew producing in the spring and fall. They obtain honeydew by tending aphids, mealybugs, and soft scales (Smith 1965). Large prey items are carried by a highly concerted group action (Trager 1984).

Formic Acid
Yellow crazy ants have also been recorded in human communities, where they are seen as agricultural pests, causing outbreaks of sap-sucking insects. They may also cause blindness in humans, especially infants, as people can get formic acid on their hands and then accidentally touch their eyes. Ants also have a detrimental effect on tourism by threatening endemic species and altering the habitat. This was the case on Bird Island after the ants eliminated the island's main attraction, the sooty terns (Sterna fuscata). More worrying is the fact that a recent study indicates that A. gracilipes has the potential to inhabit vast areas of continental Australia. By using potential distribution and climate matching researchers concluded that the ant is capable of occupying most of northern and north-eastern Australia.

New Exotic Invasive Pest
A new exotic invasive pest ant species was found around Houston (Harris County), Texas in 2002, and has begun to spread with human assistance. The ant has yet to be identified to species and is commonly referred to as the Rasberry crazy ant, Nylanderia sp. nr. pubens (LaPolla, et al). Currently, little is known regarding the biology of this ant. The Center for Urban and Structural Entomology at Texas A&M University is investigating food source attraction, colony growth and immature development.

Biology: ID Characteristics & Behavior

Worker ant body characteristics:
Coloration
Adult colony members, including queens, males and workers, are reddish-brown (although lightness or darkness of their body color may vary)

Size
Worker ants are all similar in size (they are monomorphic), with a body length of 1/8 inch.

There is a small circle of hairs (acidopore) present at tip of the abdomen (as opposed to the typical stinger found in most ants), a characteristic of formicine ants found within the Formicinae subfamily. Worker ants have long legs and antennae, although not as long as the crazy ant, P. longicornis, and their bodies have numerous, long, coarse hairs. The antenna has 12-segments with no club.

Colonies
Rasberry crazy ants have been found in enormous numbers. They are social insects that live in large colonies or groups of colonies that seem to be indistinguishable from one another.

- Colonies contain many queen ants (they are polygyne colonies), worker ants and brood consisting of larval and pupal stages. Pupae are "naked" or without cocoons. They periodically produce winged male and female forms called sexuals or reproductives.
- The size of the colony infestations can be large and display super colony (unicolonial) behavior.

Trailing behavior
Rasberry crazy ants foraging trails are quite apparent and individuals forage erratically, hence the typical reference to "crazy" ant. Foraging trails will often follow structural guidelines, however, large trails can be found in open areas.

The EPA is still working on developing a protocol for dealing with Crazy Ants, but there are a few tried and true methods that work on a wide variety of ants. Here are a few steps you can take to control Crazy Ants:

Eliminate Food and Water Sources
This is a good first step because it weakens crazy ant colonies, and weakened ants are vulnerable. Eliminating food and water sources will make your other efforts more effective and it will also prevent ant colonies from re-establishing themselves later. Crazy ants feed on sugar, honeydew from farmed insects (including aphids, cottony scales, mealybugs, soft-type scales, and whiteflies), and dead insects. If you have a hummingbird feeder, make sure that it's a model that the ants can't get into or consider leaving it empty for a few weeks. If you have a no-kill bug trap, make sure to empty it regularly or the crazy ants may be able to feed on the captive bugs. Crazy ants can tolerate water shortages, but they breed quickly in moist environments. So, you may want to consider watering less often and draining your bird baths while the problem is dealt with.

Block Points of Entry into the Home
Your kitchen and pantry are major attractions for ants. When they find bags of sugar, flour, or other packaged foods, it's like finding an open bank vault. They'll rob you blind and then use the resources to breed more foragers. It's a vicious cycle, but you can break it up with a little bit of caulk and fresh gaskets on your windows and doors. As an added benefit, this weatherproofing will also reduce your air conditioning and heating costs!

Find the Nest and Kill the Queen
It's easy to find the source of ant infestation - just follow the workers home! Even though crazy ants are more likely to wander around, they will still form easily traceable lines if they find a good source of food. You can use these lines to trace the ants' path back to a colony and attack them at the source. There are several organic treatments that have proven effective.

Digging up the colony with a shovel can also work, but the ants will attack you to defend their home. Another option is to pour boiling water or waste cooking oil on the nest - it works best if you use a long necked funnel to deliver the liquid deep into the tunnels where the queen and vulnerable larvae are found. Crazy ants are unusual because they often form "supercolonies" with more than one queen. Make sure you get all of the queens, or the colony can recover.

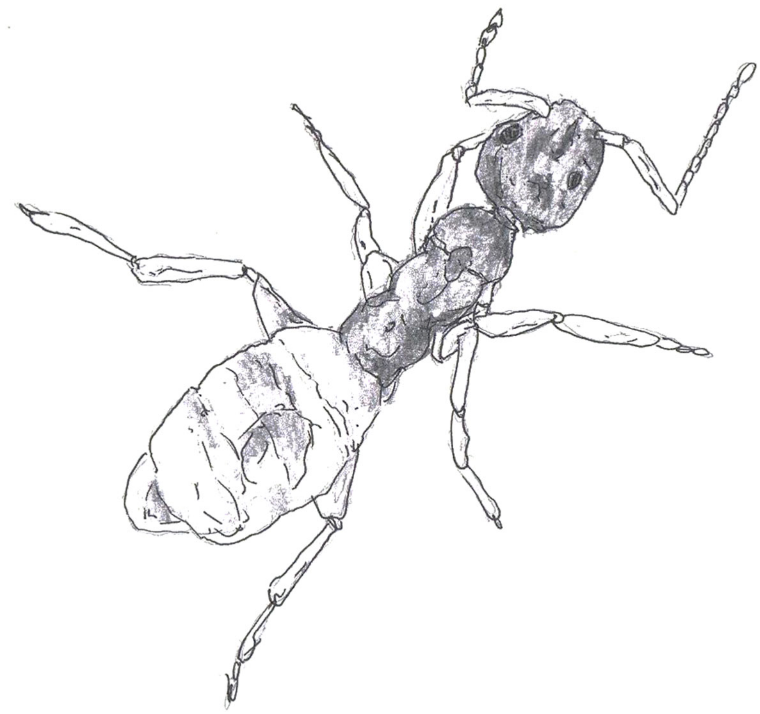
If you prefer a live-and-let-live approach, you can try putting a barrier along one side of the ant colony to redirect the ants away.
Pouring a border of dry molasses along 3 sides of the colony will be somewhat effective at directing crazy ants away from your house or garden, and can be a great option if you don't like one of your neighbors. You can also grow repellent plants around your house to keep ants away - they hate Catnip, Pennyroyal, Peppermint, Sage, and Mint. Tansy can also work, but Tansy is toxic and should be avoided if you have any pets that like to chew on plants (sheep and lambs do this, but so do some dogs and cats).

Attraction to Electrical Equipment
It is unclear why this species, like many varieties of ants, is attracted to electrical equipment, including computers and air conditioners and hair dryers. It may be that they sense the magnetic field that surrounds wires with electric current flowing through them.

Or, they might prefer the heat byproduct of resistance in the wires. However, it could simply be that they are searching for food or a nesting location that is easy to defend. Their infestation of electrical equipment can cause short circuits when they chew through insulation. Overheating and mechanical failures can also be caused by high numbers of dead worker ants in electrical devices.

When mounds cannot be located, spraying the window seals and cracks with Cypermethrin (Cynoff EC, Cynoff WP, Demon WP or Demon WP) and using a sweet bait or dual bait such as Gourmet or Advance Dual Choice in the house is a great combination. NEVER use an indoor spray if you are incorporating the use of an indoor ant bait! Such tactics will usually contaminate your bait, resulting in failure to control the pests.

Ghost Ant *Tapinoma melanocephalum* - 1 Node Ant
Subfamily Dolichoderinae



GHOST ANT

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).

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

Key
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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 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.

Detergent Barrier
Temporary "moats" of detergent and water may be useful during heavy ant invasions.

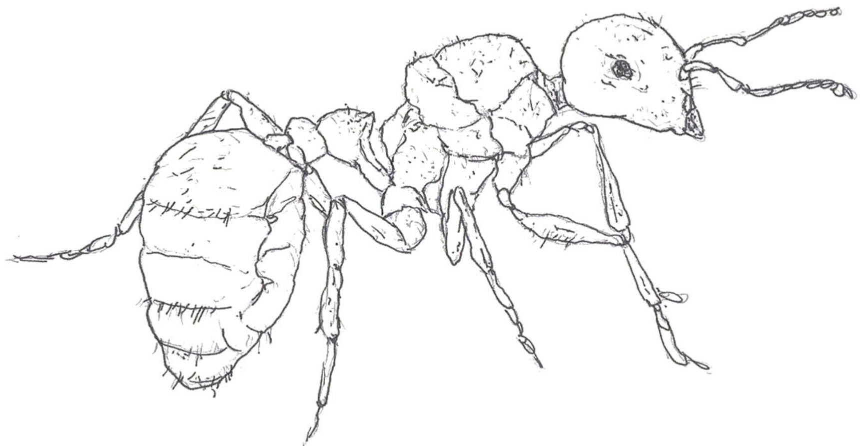
- Containers of food or food waste which must remain open during working hours can be placed in large, shallow pans filled with water mixed with a small amount of detergent.
- Use this technique to protect potted plants from ants that may be attracted to nectar produced by the plant or to honeydew produced by plant-feeding insects. Elevate the pot above the detergent-and-water mixture by placing it on an overturned saucer. Make sure the limbs and leaves of the plant are not in contact with surfaces that ants could use as bridges.

Chemical Controls
At times, non-chemical methods alone prove insufficient to solve the problem. Integrating a pesticide into your management program may be necessary to gain control of the ant problem.

Pesticides must be used in accordance with their EPA-approved label directions. Applicators must be certified to apply pesticides and should always wear protective equipment during applications. All labels and Material Safety Data Sheets (MSDS) for the pesticide products authorized for use in the IPM program should be maintained on file. Do not apply these materials when buildings are occupied, and never apply them where they might wash into drains or sewers. When treating ants, all baits and dusts should be placed in cracks, crevices, and in precise areas where ants are active.

Detergent and Water
When ants invade a classroom or food preparation area, use a mixture of soap and water in a spray bottle. This mixture will quickly kill the ants which can then be wiped up with a sponge and washed down the drain. Each classroom, cafeteria, and food preparation area should be equipped with such a spray bottle so teachers and staff can safely deal with emergencies.

Harvester Ant - 1 Node Ant



HARVESTER ANT

Red Harvester ants are very common in Arizona and I've found these living inside buried coffins. Think about that one for a while. These creatures range from 3/8-inch to 1/2-inch in length. The color varies from red to reddish brown to black, depending on the species. The main food source for red harvester ants usually consists of seeds, which they hoard in great numbers, hence their name. As with most ant species, their mating castes consist of winged alates (reproductives) that reside in the nest until weather permits them to fly away and mate. After that the male usually dies, while the now-fertilized queen returns to the ground to search for a suitable nesting site. Once she has chosen a site, she sheds her wings and begins to reproduce, creating a new colony. She produces "worker ants" for 1–20 years until her death.

Red Harvester ants can be aggressive and have a painful sting that spreads through the lymph nodes, sometimes causing reactions, especially in animals allergic to their venom. They can also bite ferociously.

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 native species, 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 geniuses.

Red harvester ant nests are characterized by a lack of foliage and small pebbles surrounding a hole that is usually at grade. In grassland areas, like ranches, the lack of plant life makes red harvester ant colonies very easy to spot. The mounds are typically flat and broad, 0 to 100 mm (0 to 3.9 in) high, and 300 to 1,200 mm (12 to 47 in) in diameter. There have been reports of even larger denuded areas, on the order of 10 m2 (110 sq. ft). Three to eight trails typically lead away from the mound, like "arms". These trails are used by ants to collect and bring food back to the mound.

"Scout" ants are the first ones out of the mound every morning. They seek food, and mark their path as they return to the mound to alert the worker ants. The worker ants follow the scent trail and collect the food. Other ants, called "middens", spend their time cleaning and tending to the mound. All worker ants and middens are female.

Harvester Ants Description

Adult -- The harvester ants are large ants 5 to 6 mm in length and different species can vary in color from reddish-brown to yellow or black. The pedicel (or stalk) between the abdomen and thorax has two segments. They have elaborate fringes of hairs underneath the head. As is the case with other ants, adults may be winged males or females, or workers (wingless females). Winged ants have two pairs of wings, the anterior pair being much larger than the second pair.

Egg -- The eggs are minute, less than 0.5 mm long, white and elliptical in shape.

Larvae -- The larvae are white and legless. The body is covered with short hairs and is shaped like a crookneck squash or gourd with a small distinct head.

Pupa -- Found in a cocoon, the pupa resembles the larva except that the body is straight and rigid with legs and wings visible.

Key

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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.

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Key Words

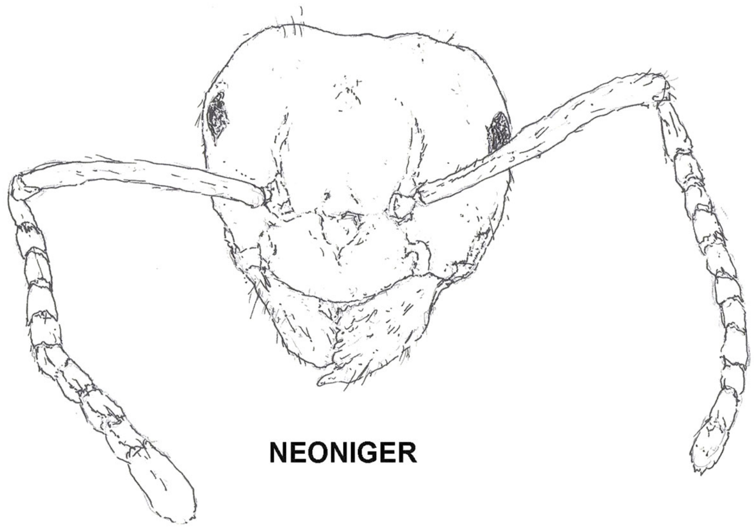
Protectant: A pesticide applied to a plant or animal prior to the appearance or occurrence of the pest in order to prevent infection or injury by the pest.

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.

Lasius Neoniger *AKA Cornfield Ant* – 1 Node Ant

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

Lasius neoniger is found commonly in open areas (prairie, parks, rough lawn, roadside) of eastern North America. 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.

A mature colony of *L. neoniger* consists of one queen, whose only function is to produce eggs and female workers that perform many functions that maintain and help expand the colony over her lifetime which can be four or more years. Males whose only function is to mate once are produced once each year and die after mating.

Development of a new colony begins with a winged virgin female (10X larger than workers) that flies from a mature colony (2,000-10,000 workers). While airborne, she mates with winged males (drones) that have flown from nearby colonies. The drone sperm is deposited into a storage organ (spermatheca) within the body of the female and is released to fertilize eggs she lays throughout her entire lifetime. The queen controls whether or not an egg is fertilized.

If unfertilized, the egg develops into a male. The female mates once and upon landing she chews or rubs off her wings, creates a chamber about an inch into the soil and remains there throughout the winter.

Research in the laboratory has shown that mated females require a “cool down period” (10 weeks at 40ºF) before being able to lay eggs. When soil temperatures rise in the spring, the mated “potential” queen, called a foundress, lays a small number of eggs that develop into larvae which become small workers. The queen feeds these first larvae with regurgitate from her body or eggs she lays. Once these larvae develop into small workers, the foundress can be considered a “queen” with “subjects” whose function is to feed and care for her and her progeny.

The small workers tunnel to the surface and begin foraging for food to feed the queen. Mounds created by these workers may be too small to see. If adequately fed, the new queen will lay many more eggs resulting in normal size workers that forage for food to feed her. Well-fed and cared for the queen increases egg production. The workers collect the eggs and carry them off to “brood chambers” where they will hatch into larvae that develop into more workers.

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).

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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.

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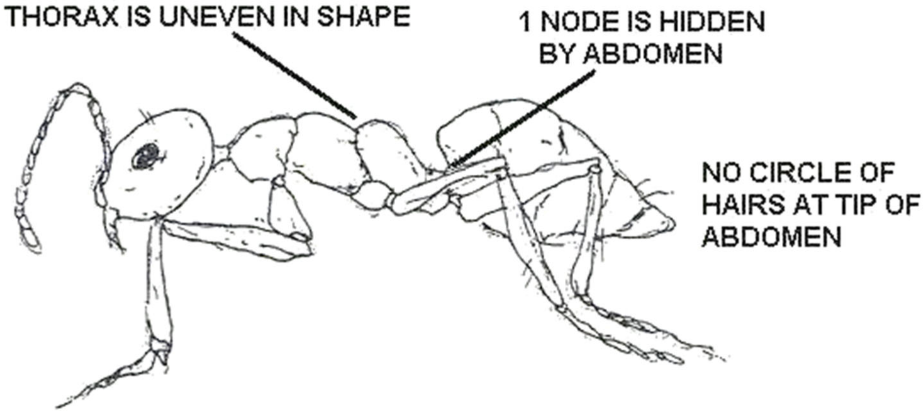
Outside, inspect along the foundation wall, patio, and sidewalks by pulling back the grass and/or mulch. Then pull back any mulch at the base of trees and shrubs with a rake. Check debris in tree/shrub crotches using a screwdriver because ants also nest here.

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.

Odorous House Ant – 1 Node Ant



ODOROUS ANT (TAPINOMA SESSILE)

Here is a money maker, the treatment of these creatures. This native species, found throughout the United States, produces a foul odor when crushed. It smells like a "*rotten coconut*". Some like to call these little critters "*Piss Ants*". The odorous house ant has become the most common and difficult ant species to control throughout much of the United States. The ant is small (1/8-inch), darkish, and forms distinct trails (shown left) along outdoor and indoor surfaces.

It is often mistaken for the pavement ant, which can readily be controlled with most baits. The most accurate diagnostic difference, visible under magnification, is the absence of a noticeable node or "bump" along the constricted area between thorax and abdomen of the odorous house ant. Pavement ants have two obvious nodes, and fine grooves or striations along the head and thorax. Pavement ants also are more likely to displace bits of soil from their typical nesting location under sidewalks, driveways and other paved areas.

Odorous house ants emit what's been described as a rotten coconut or pine scent when crushed with a finger and sniffed.

Odorous house ants will nest in virtually every imaginable location. They commonly nest outdoors under pavement, stones, mulch, woodpiles, flower pots, and house siding, foraging indoors for food and moisture. Nests also occur indoors within wall cavities, appliances, potted plants, etc., especially near sources of moisture. The nests tend to be mobile; colonies relocate fast and often in response to changes in weather and disturbance.

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 plant lice (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.

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 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.

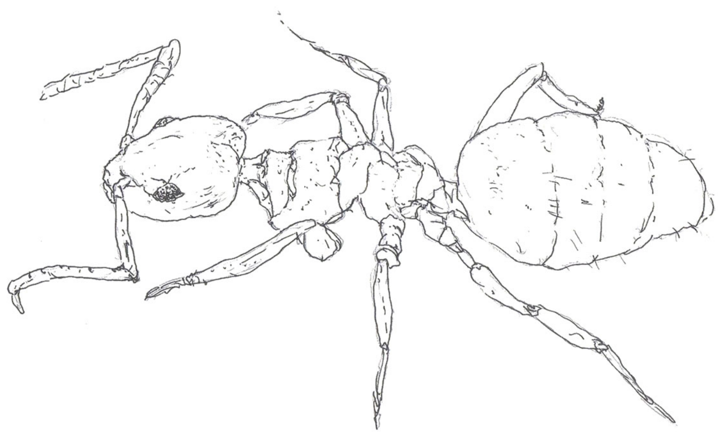
Ant Key Words

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.

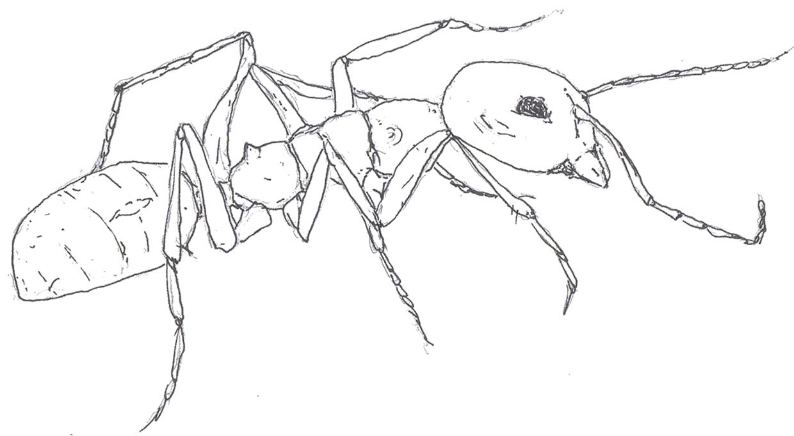
Tramp: A widespread ant species spread by human commerce with a specific syndrome of life history characteristics: extreme polygyny, unicolonial or highly polydomous nest structure and colony reproduction by budding.

Transferred: Collected outside native habitat, without knowledge of established nests.



ODOROUS HOUSE ANT

Pyramid Ant – 1 Node Ant



PYRAMID ANT

Pyramid ants are pale orange to dark brown in color. They are slender with a pyramid-shaped projection on its thorax. Range from 1/12-inch to 1/6-inch in length. Nest in soil, sandy soil preferred. Typically, nest has a single entrance surrounded by crater-shaped mound of soil and a single queen per nest. One dark colored species, however, is a temporary parasite on the most common orange species and occupies a number of nests at a time, with multiple queens.

Pyramid ants move quickly and forage in strong, easily detected trails. They are similar to fire ants in that often nest in open, sunny areas, and are rarely found indoors. They can also be found around patios, porches and decks. They feed on other insects and honeydew, and are particularly fond of sweets.

Pyramid ant colonies are small and nesting chambers are formed just below the surface of the soil, providing easy access to the entire colony. Individual colonies can be treated by injecting an appropriate insecticide directly into the entrance hole using a compressed air sprayer. The use of a crack and crevice tip fitted on the spray nozzle should be inserted directly into the entrance hole. Two or three ounces are needed to treat each colony. Colonies found under items on the ground can be drenched with a few ounces of insecticide. Baits containing a sweet attractant can be effective in areas where workers are active but the colony cannot be located.

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.
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- 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.

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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 ant invasion from the outside, a perimeter treatment using a microencapsulated or wettable powder formulation of pyrethroid should be applied.

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.

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.

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.

Ant Key Words

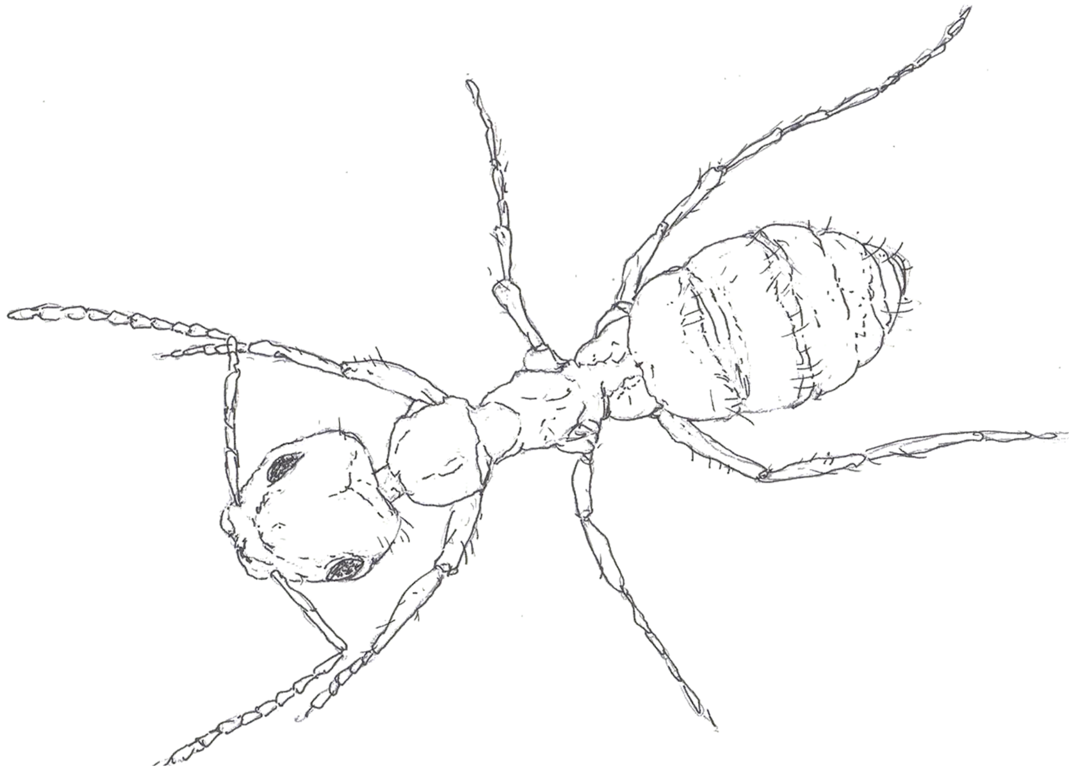
Larval stage (larva, larvae): An immature insect, sometimes used to include all immature stages, even eggs. Usually this term refers more specifically to the feeding stages of insects with complete metamorphosis like grubs, caterpillars, and maggots.

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.

Rasberry Ant *Also see Crazy Ant for more Information* – 1 Node Ant



RASBERRY ANT

The description of the Rasberry crazy ant is very similar to the species description for Nylanderia pubens, the Caribbean crazy ant. Research on the correct identification of this ant in Texas, including the morphology and phylogenetic characteristics, is ongoing. The ants are about 3 millimeters long (equivalent of one-eighth inch) and are covered with reddish-brown hairs.

The colonies have multiple queens. They feed on ladybugs, fire ants and Attwater's prairie chicken hatchlings, as well as plants. They are able to out-compete fire ants because they reproduce faster. The ants are not attracted to ordinary ant baits, are not controlled by over-the-counter pesticides, and are harder to fully exterminate because their colonies have multiple queens.

Attraction to Electrical Equipment

It is unclear why this species, like many varieties of ants, is attracted to electrical equipment, including computers and air conditioners and hair dryers. It may be that they sense the magnetic field that surrounds wires with electric current flowing through them. Or, they might prefer the heat byproduct of resistance in the wires. However, it could simply be that they are searching for food or a nesting location that is easy to defend.

Their infestation of electrical equipment can cause short circuits when they chew through insulation. Overheating and mechanical failures can also be caused by high numbers of dead worker ants in electrical devices. When mounds cannot be located, spraying the window seals and cracks with Cypermethrin (Cynoff EC, Cynoff WP, Demon WP or Demon WP) and using a sweet bait or dual bait such as Gourmet or Advance Dual Choice in the house is a great combination.

NEVER use an indoor spray if you are incorporating the use of an indoor ant bait! Such tactics will usually contaminate your bait, resulting in failure to control the pests. Simply picking up rocks and debris around the house will also help. If the ants are nesting in the house, the wall voids will need to be dusted with Drione in areas where ant baits are not to be used. Ant infestation 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.

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.

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.

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.

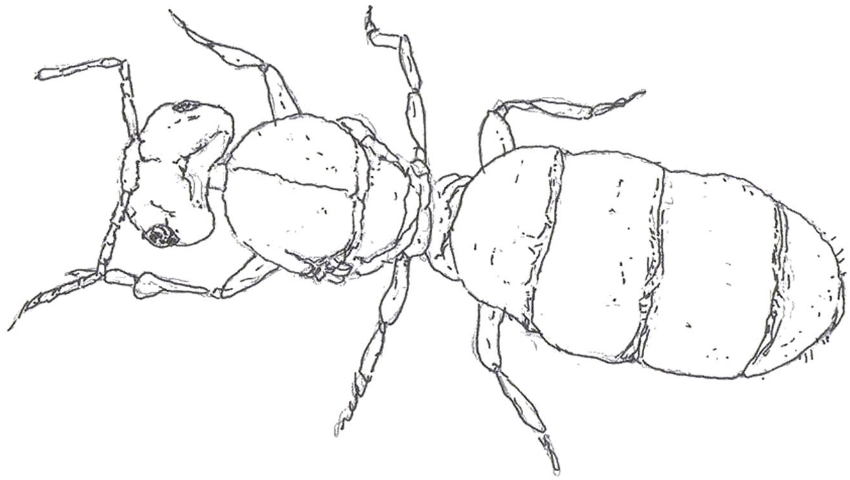
Bendiocarb
Applications of bendiocarb (Ficam), which is odorless, can give fast eradication of ants if treatments are thorough. Ficam 76 percent WP and 91 percent dust is labeled for licensed commercial and pest control operators. The bait products most recommended for Pharaoh ant control include: (boric 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.

These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them.

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

Rover Ant Information and Control – 1 Node Ant
Brachymyrmex spp.



ROVER ANT

Rover Ants were noticed around 40 years ago, but are just now gaining attention as they have become a serious pest problem in many areas of the country. The Rover ant is often mistaken for the little black ant, resulting in failure to control the targeted ant pest.

Unlike the Little Black Ant, the Rover ant has only one queen and can have many colonies in one area. It can be very frustrating to eliminate all of the colonies.

The Rover ant is very small (1/16 to 1/12 of an inch) and can be blonde to dark brown in color. They have one node which has a low peak and is sloped slightly forward of the abdomen is generally carried forward and hides the node. The key to identifying the Rover ant is its 9 segmented antennae which is not clubbed. Another physical characteristic of the Rover Ant is that it does not have a stinger. The workers of this ant species are all one size (monomorphic).

Rover Ants are most often found dead in swimming pools or running vigorously up and down vertical objects such as a blade of grass or the leg of a patio chair. In the wilderness they nest under stones, in the soil or in rotting wood.

In buildings we are finding them in high moisture areas such as bathrooms, kitchens or rooms with past water problems. They can also form sub slab colonies. Rover Ants feed on honeydew which is produced from aphids and mealy bugs. Female winged ablates are three times larger than male workers.

Controlling Rover Ants
By broadcasting a good residual insecticide such as Talstar over lawns and nearby shrubs to kill off the ants, much of their food source (sap sucking insects which provide honeydew) can also be controlled. Exterior surfaces of the home, garage, shed or other structures in infested areas will also help control foraging Rover ants.

Indoor control of Rove Ants will be aided by the exterior spray, but if the indoor populations are too high in number then other actions can be taken.

When indoor sprays are not favorable or practical, use a good bait for sweet feeding ants. Gourmet Ant Bait Gel is an excellent choice for controlling indoor Rover Ant populations, whether they are merely scouting for food or have established colonies in the voids found inside the average home.

When mounds cannot be located, spraying the window seals and cracks with Cypermethrin (Cynoff EC, Cynoff WP, Demon WP or Demon WP) and using a sweet bait or dual bait such as Gourmet or Advance Dual Choice in the house is a great combination. NEVER use an indoor spray if you are incorporating the use of an indoor ant bait! Such tactics will usually contaminate your bait, resulting in failure to control the pests.

Simply picking up rocks and debris around the house will also help. If the ants are nesting in the house, the wall voids will need to be dusted with Drione in areas where ant baits are not to be used. Ant infestation 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.

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 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.

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.

These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them.

Types of Common Building Treatment Applications

Spot treatment is application to small areas where insects walk but will not contact food, utensils, or workers. Such areas are on floors, walls, or bases or undersides of equipment. Spot treatments should not exceed 2 square feet. In many cases, spot treatments are only allowed in non-food areas. Check the label to be sure of the proper
use of spot treatments.

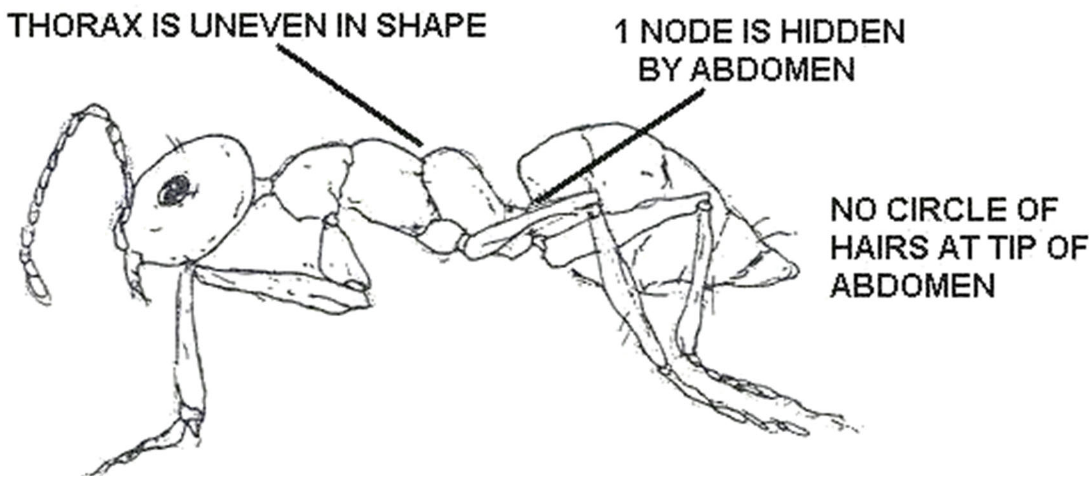
Crack and crevice treatment is the application of small amounts of pesticides into cracks and crevices that pests use to enter buildings. These commonly occur at expansion joints. They occur between equipment and floors. The openings may lead to hollow walls, equipment legs and bases, conduits, motor housings, or junction or switch boxes. You can use liquids, dusts, or baits for crack and crevice treatments. These products can be used in food areas if the pesticides are placed into cracks and crevices.

Residual pesticides may be applied when food establishments are in operation unless the product label prohibits it.

When using *non-residual pesticides* (effects only during the time of treatment) as space treatments (aerosol, ULV and fog), the application should be made when the establishment is not in operation and foods are removed or covered. Food handling surfaces should be cleaned before use.

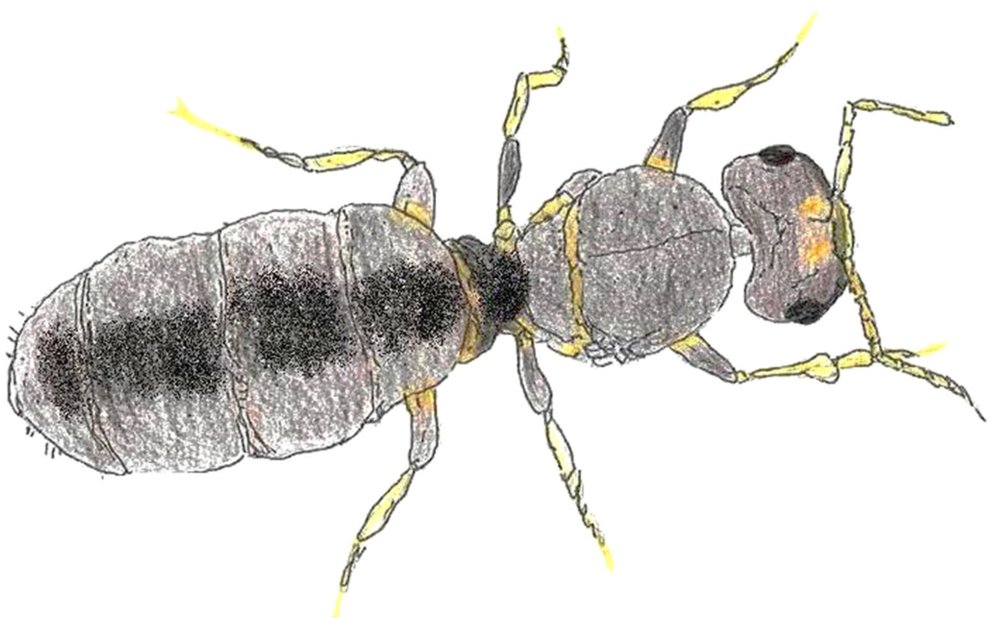
If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use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

Hidden Node Ant Sub-Section



ODOROUS ANT

Odorous Ant
Odorous House ants are dark brown to black in color. Technical classified as 1 node but difficult to see the node. Typically 1/8-inch long.



ROVER ANT

Rover Ant
Rover ants are yellow-blonde to dark brown in color, with the abdomen appearing swollen or humped at the front end. Technical classified as 1 node but difficult to see the node. Range from 1/16-inch to 1/12-inch in length.

WHITE FOOTED ANT

White-Footed Ant
The white-footed ant is a 1/10 to 1/8 inch (2.5-3 mm) long, black to brownish-black ant. It is called the white-footed ant because the "foot" (which actually is the lower part of the leg known as the tarsus) is yellowish-white.

The waist has only one knob-like node and each antenna has 12 segments. The white-footed ant does not have a sting. Technical classified as 1 node but difficult to see the node

Topic 3 - One Node Ant Identification and Control Section Post Quiz

1. Ants are distinct in their morphology from other insects in having elbowed antennae, metapleural glands, and a strong constriction of their second abdominal segment into a node-like petiole. The head, mesosoma, and metasoma are the three distinct body segments.
True or False

2. Termites also develop wings and swarm during the spring and look similar to flying ants. 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.
True or False

3. Which ants tunnel into wood to form nest galleries. If they go unnoticed for several years, they may cause structural damage?

4. Once an active carpenter ant nest is found, treatment is usually easy with either a(n) ___________. Injection of insecticide into wall voids or the nest itself may be necessary to reinsure complete control.

5. 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.
True or False

6. A satellite nest requires moisture because the workers tend eggs (the eggs would dry out without sufficient humidity). For this reason, satellite nests can be found in relatively wet locations, such as insulation, hollow doors, and sound wood.
True or False

Indoors
7. Ant nests are often concealed in wall voids, ceilings, subfloors, attics, or hollow doors. It is usually necessary for a professional pest control applicator to drill small (about 1/8 inch) holes and apply an insecticidal dust into the nest area. It is best to determine the nest’s location as specifically as possible.
True or False

Perimeter Insecticide Treatments

8. 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 Ammoniacal copper zinc arsenate and Chromated Copper Arsenate (CCA) are the best.
True or False

Bendiocarb

9. Applications of bendiocarb (Ficam), which is odorless, can give fast eradication of 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)).
True or False

Harvester Ant - 1 Node Ant

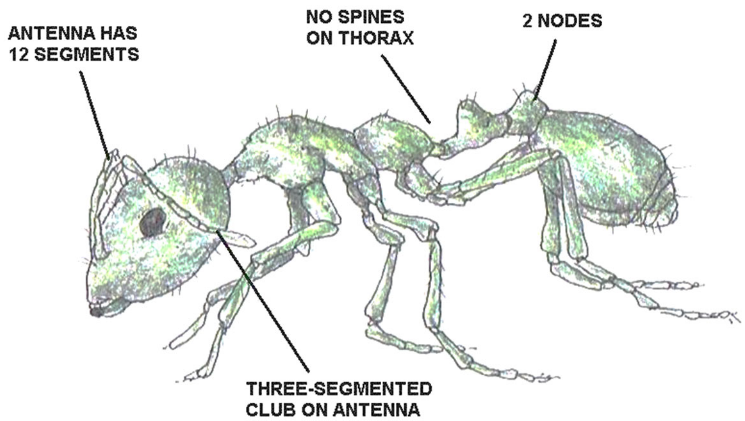
10. Red Harvester Ants are not aggressive and lack a painful stinger.
True or False

Answers

1. True, 2.True, 3. Carpenter, 4. Insecticide dust or spray, 5. True, 6. False, 7. True, 8. False, 9. True, 10. False

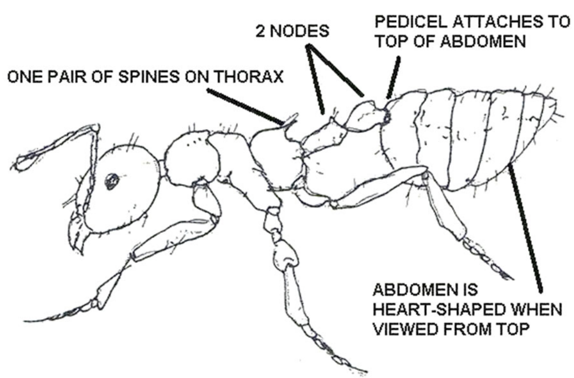
Topic 4 - Two Node Ant Identification and Control Section

Topic 4 - Section Focus: You will learn the basics of two node ant identification and control techniques. At the end of this section, you will be able to understand and describe two node ant control and elimination techniques. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.



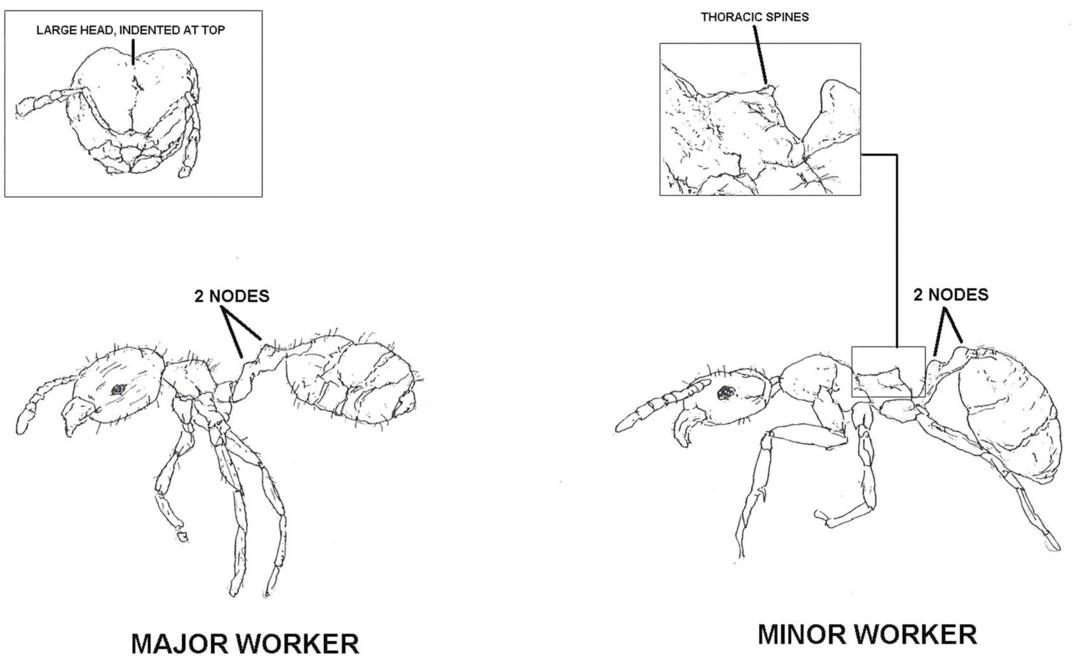
LITTLE BLACK ANT

Little Black Ant (*Monomorium minimum*) is a species of ant. Members of the species are tiny and shiny black in color. These ants are pests that are usually found outdoors or in wood inside a home that causes it to decay. Workers are 1/16 inch in length and the queens are 1/8 inch in length. They use recruitment to deal more effectively with large prey. They form colonies with multiple queens. Ants give birth to live pupa. Ant pupa laid by the queen can take just 10 days to mature. Winged ants may fly away and start a new colony if the current colony is overpopulated.

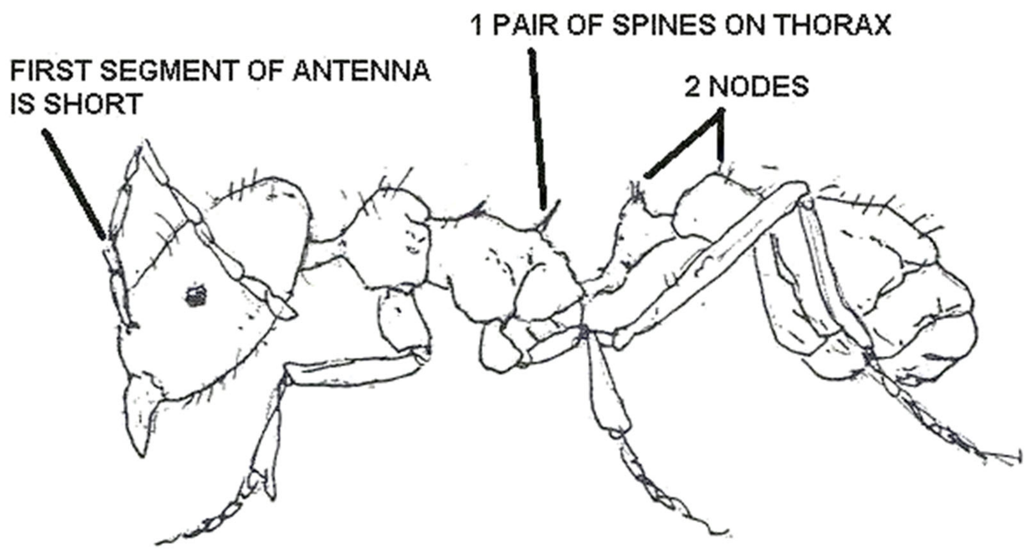


ACROBAT ANT (CREMASTOGASTER LINEOLATA)

Acrobat Ant
Acrobat ants have very shiny bodies that vary in color from light red to dark brown or black. They have a heart-shaped abdomen, and get their name from the unique habit of running with it bent up and over their thorax when bothered or agitated, and may sting or bite. They are often very shiny. Range from 1/8-inch to more than a ¼-inch in length.

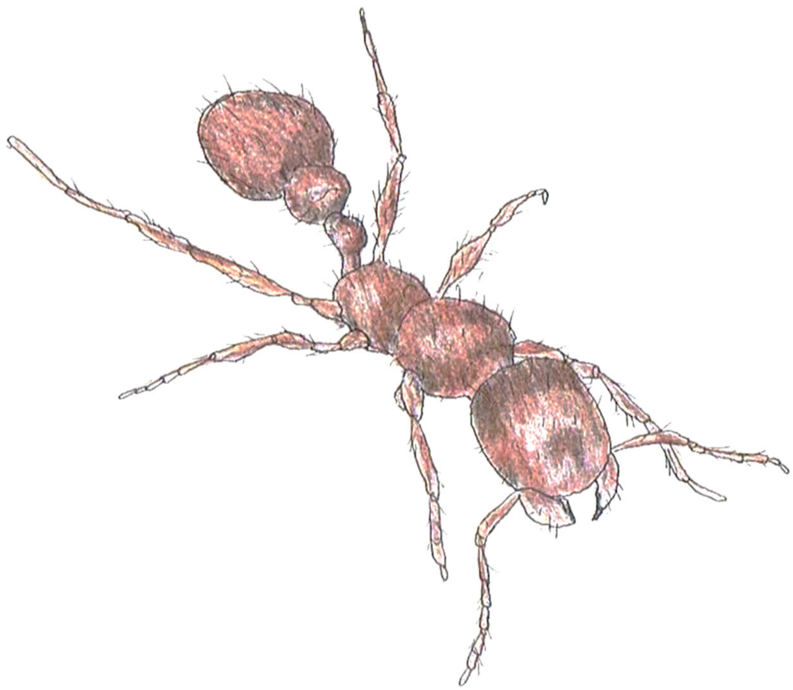


BIG HEADED ANT DIAGRAM COMPARISON

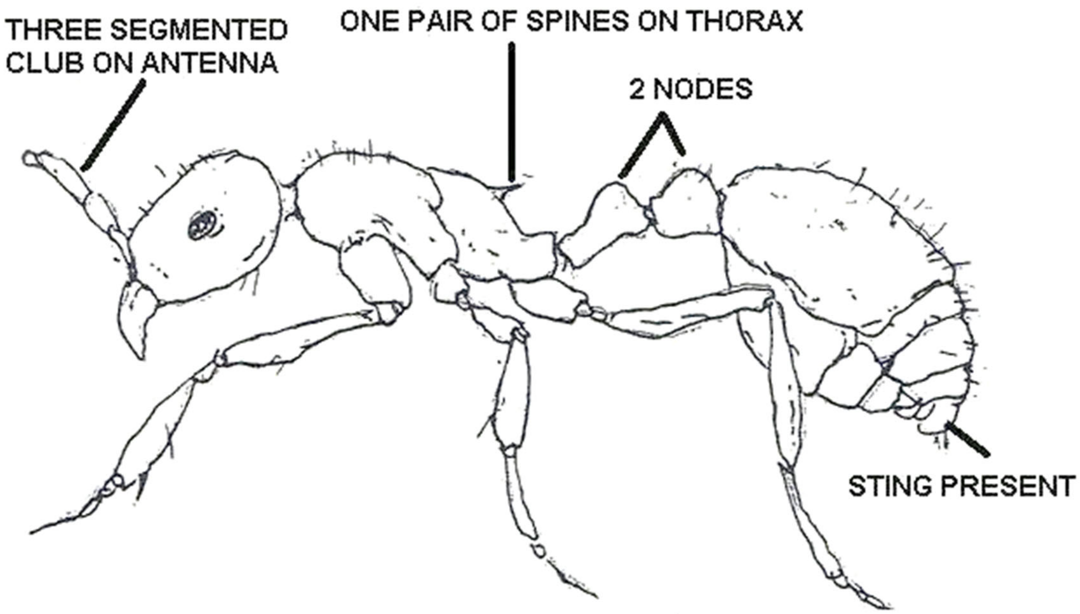


BIG HEADED ANT (PHEIDOLE SPP.)

Big Headed Ants
Big-headed ants are light brown to dark reddish brown in color. They have two different size workers: major workers heads are very large in proportion to their bodies. The minor workers do not have large heads. Range from 1/16-inch to 1/8-inch in length.

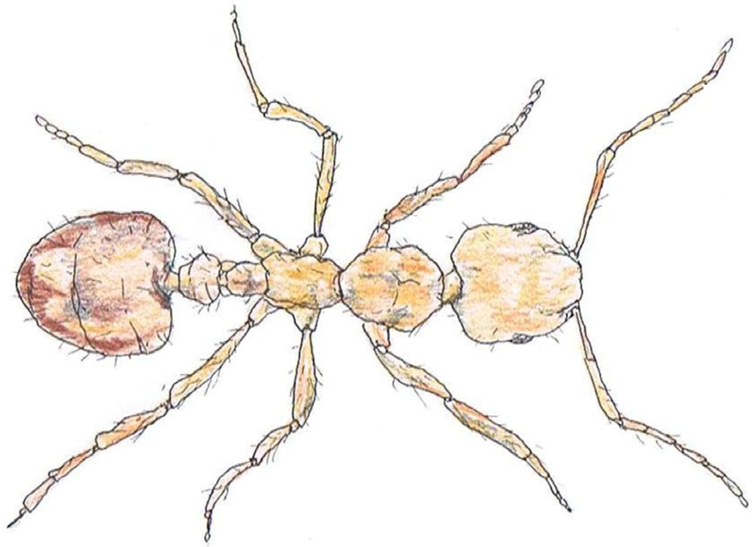


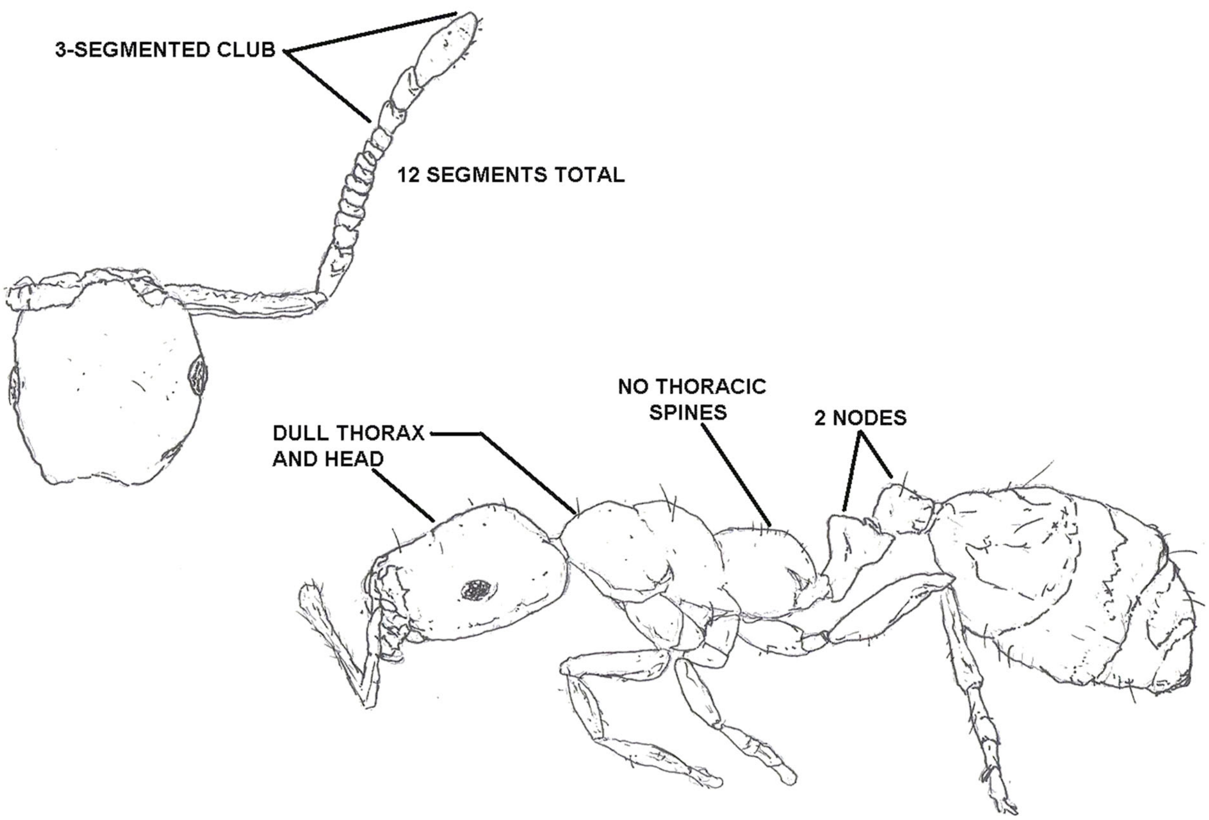
PAVEMENT ANT



PAVEMENT ANT (PHEIDOLE APP.)

Pavement ant (Tetramorium caespitum)
Food: sweets, proteins, grease. **Nest**: in lawns or under stones, boards; build mounds along sidewalks, foundations, and near water. 3/16 inch, dark brown to black.

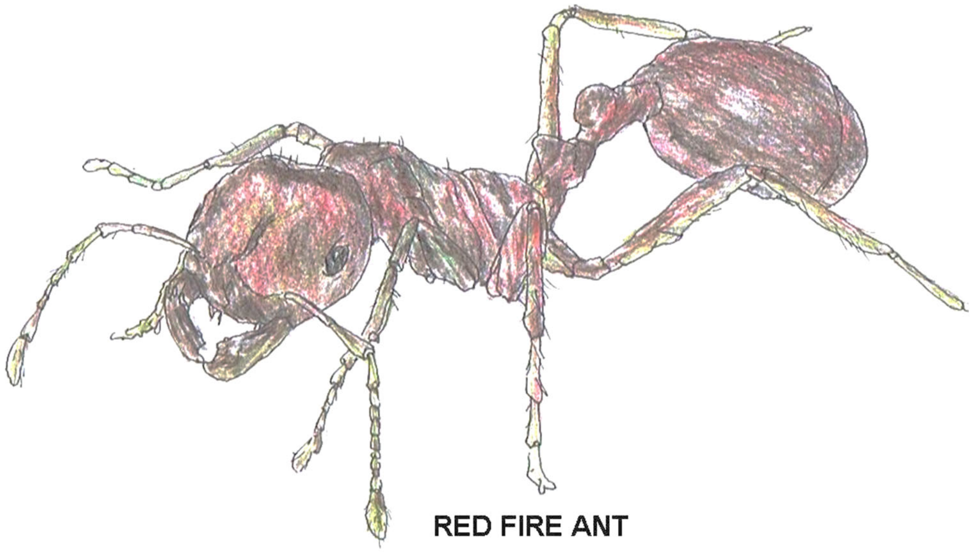




PHARAOH ANT

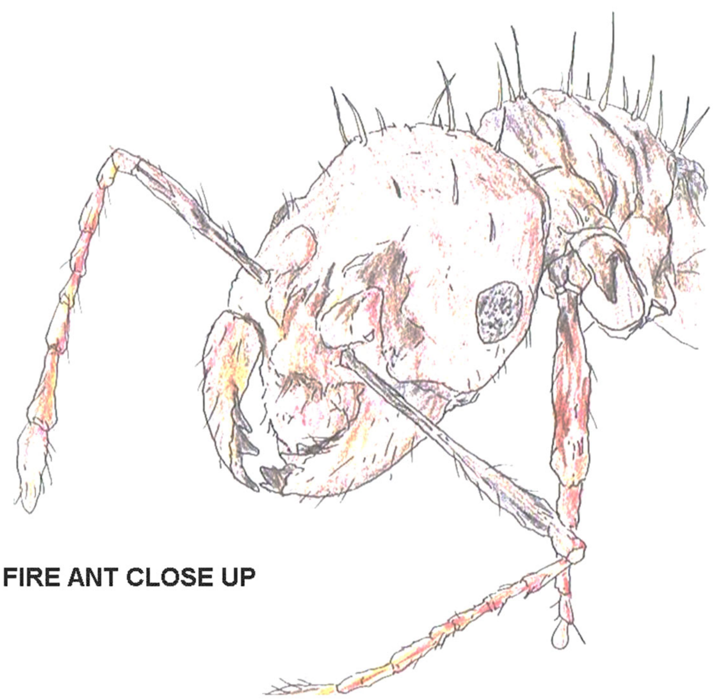
Pharaoh ant (Monomorium pharaonis)

Food: fats, proteins, sweets. **Nest**: in wall or cabinet voids, behind baseboards, or insulation or outdoors in debris. 1/16 inch, yellow or honey colored to orange.



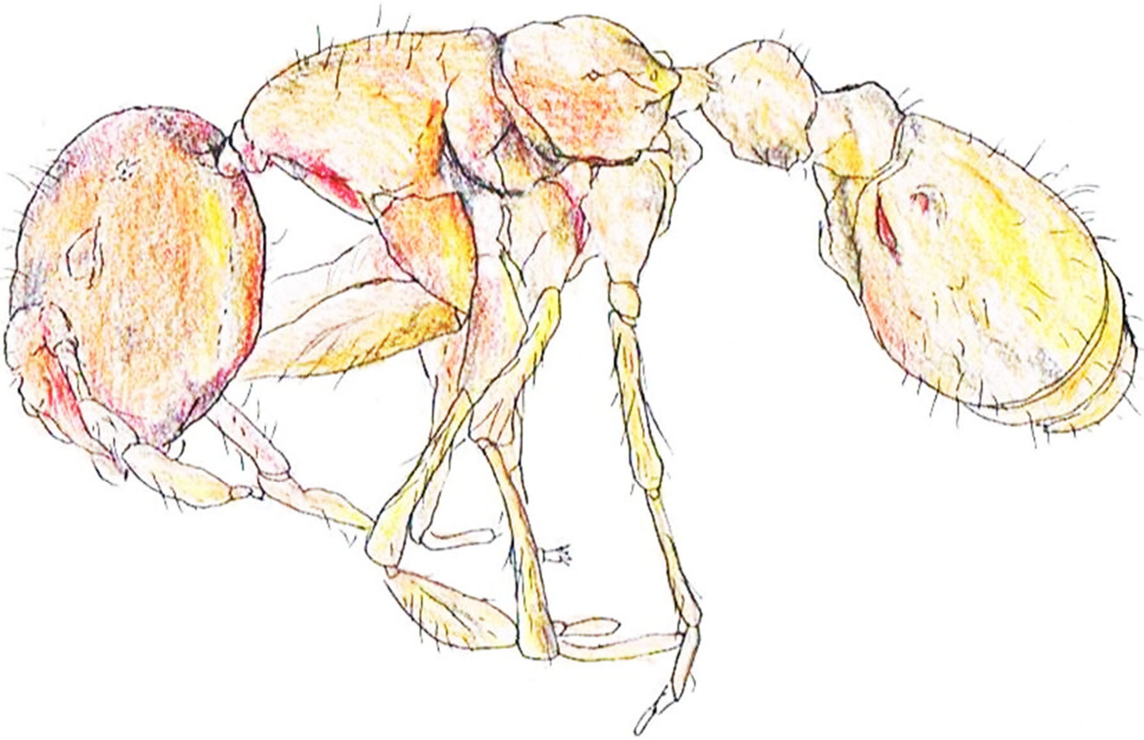
RED FIRE ANT

Red imported fire ant (Solenopsis invicta)
Food: sweets, proteins. **Nest**: in mounds with multiple openings in soil or lawns and sometimes in buildings behind wall voids. 1/16 to 1/5 inch, reddish with dark brown abdomen

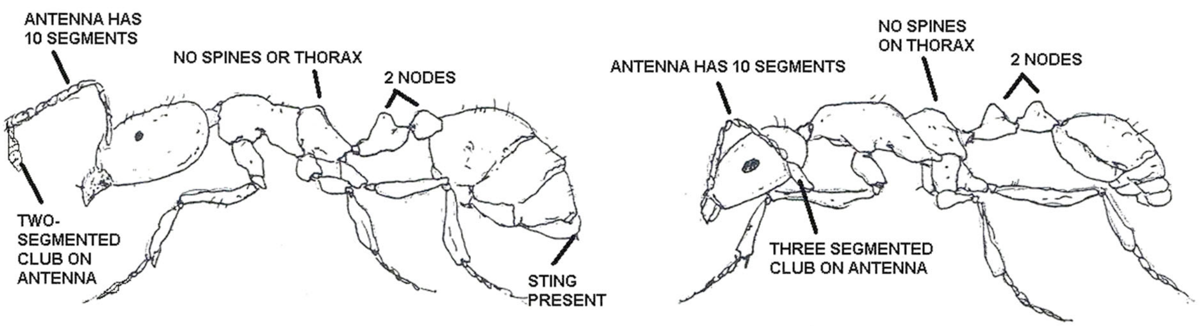


FIRE ANT CLOSE UP

Southern fire ant (Solenopsis xyloni)
Food: proteins and sweets. **Nest**: in small mounds with flattened irregular craters in wood, under rocks. 1/8 to 1/4 inch, amber head and thorax with black abdomen, body covered with golden hairs.

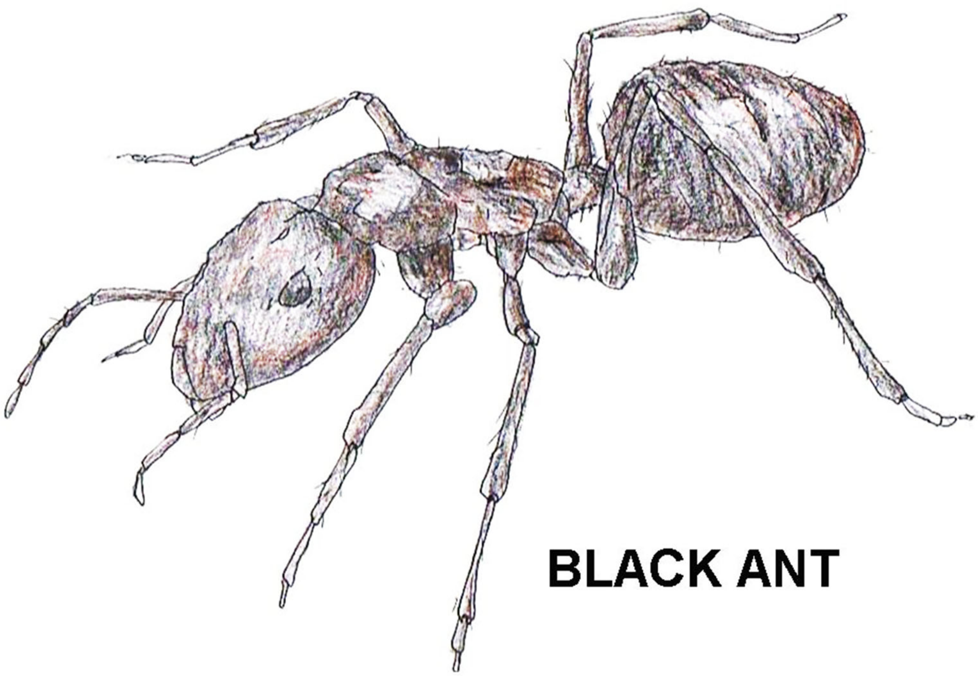


THIEF ANT

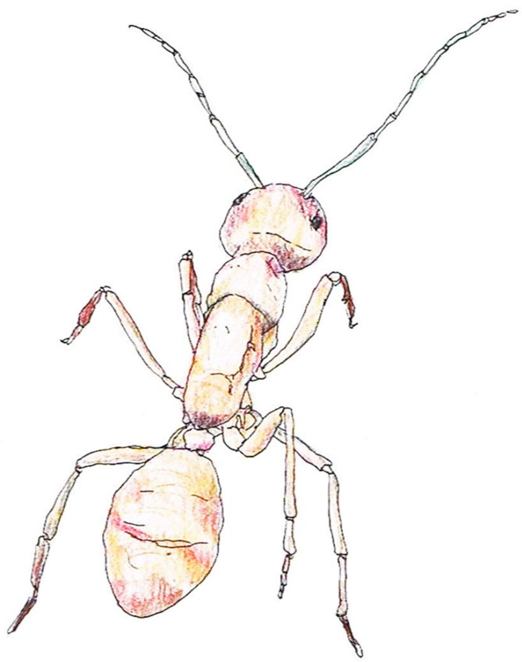


THIEF ANT (SOLENOPSIS MOLESTA) VS. PHARAOH ANT (MONOMORIUM PHARAONIS)

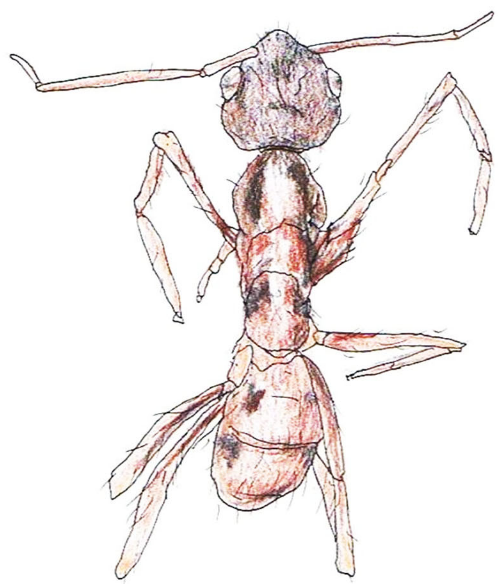
Thief Ant (Solenopsis molesta)
Food: greasy and fatty foods, sometimes sweets. Steal food and ant larvae from other ant nests.
Nest: outdoors in soil, under rocks or decaying wood or indoors behind wallboards or baseboards.
1/32 inch, yellow to light brown



BLACK ANT

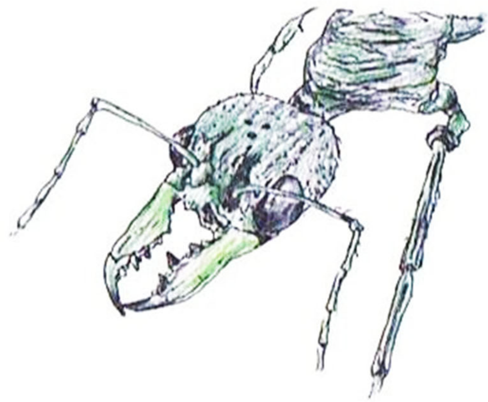


YELLOW ANT



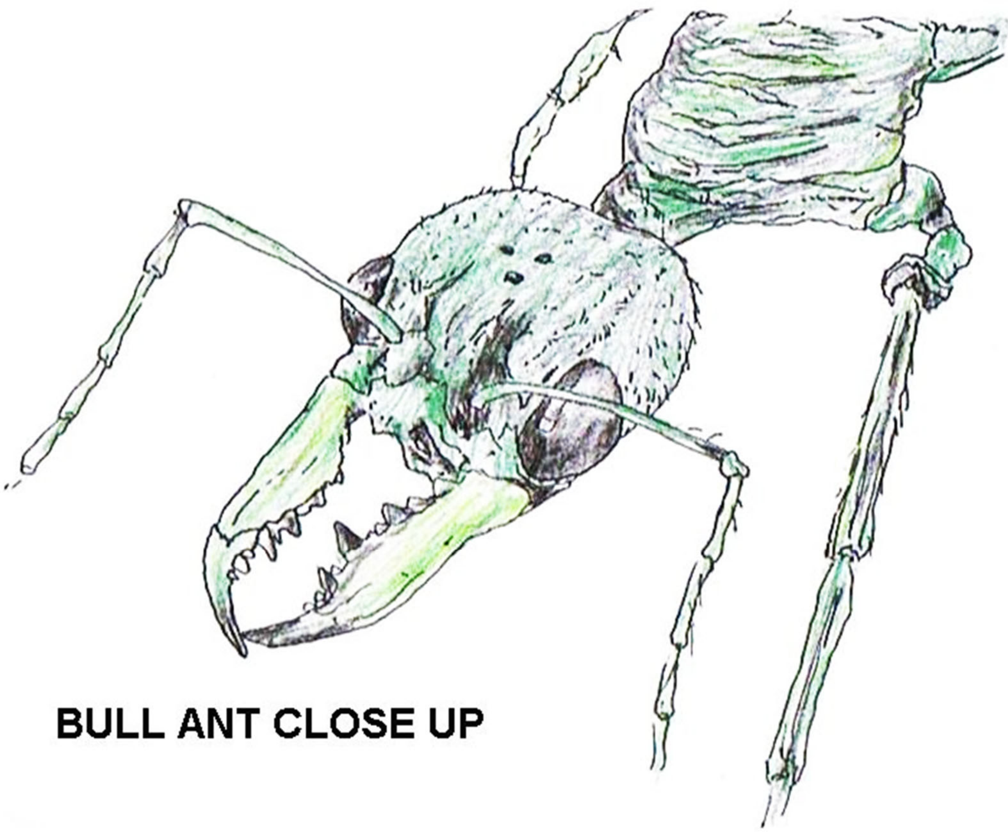
CRAZY ANT

FIRE ANT

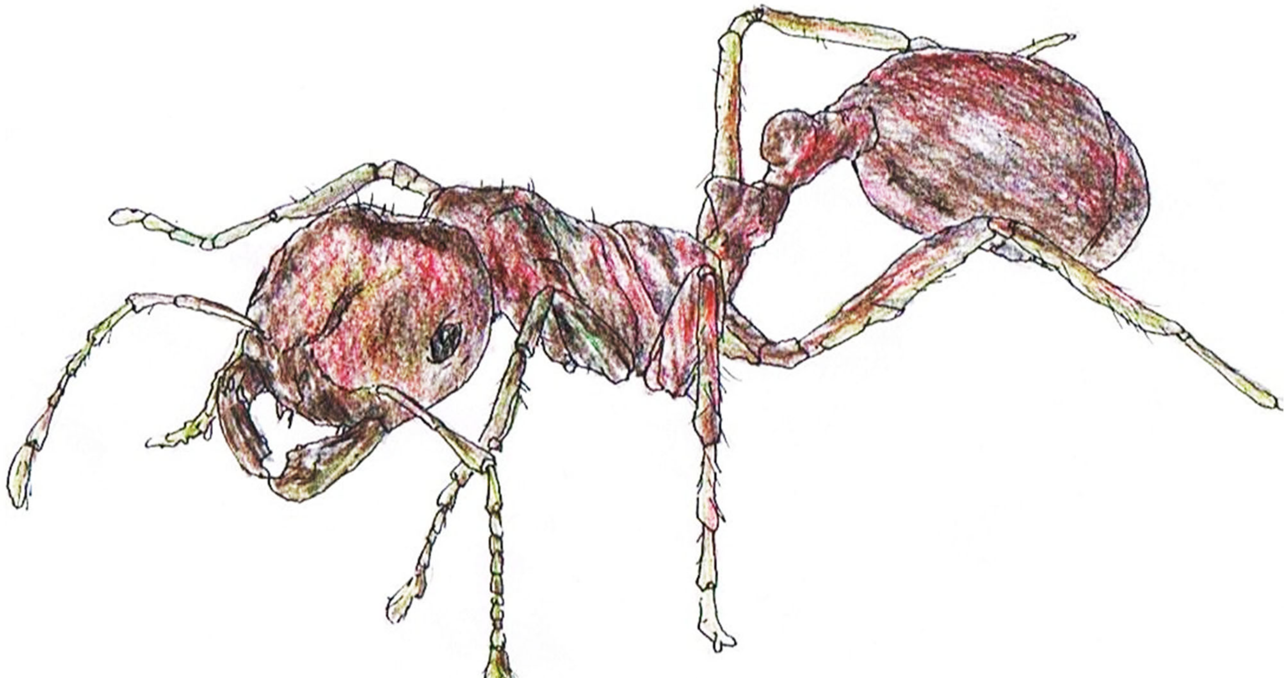


BULL ANT

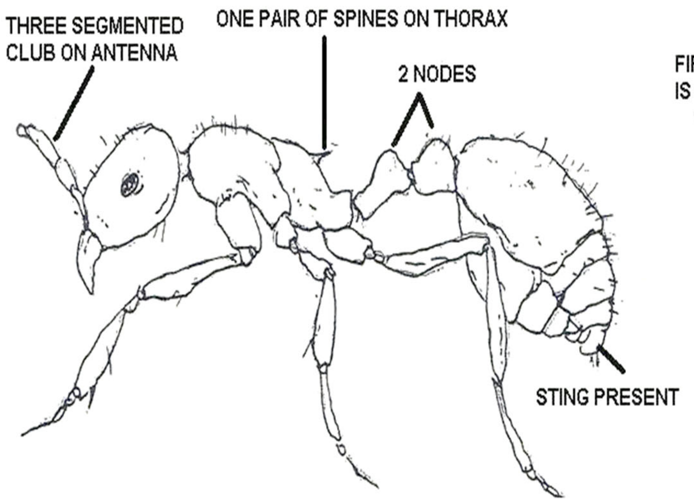
CLOSE-UP COMPARISON OF THE FIRE AND BULL ANT



BULL ANT CLOSE UP

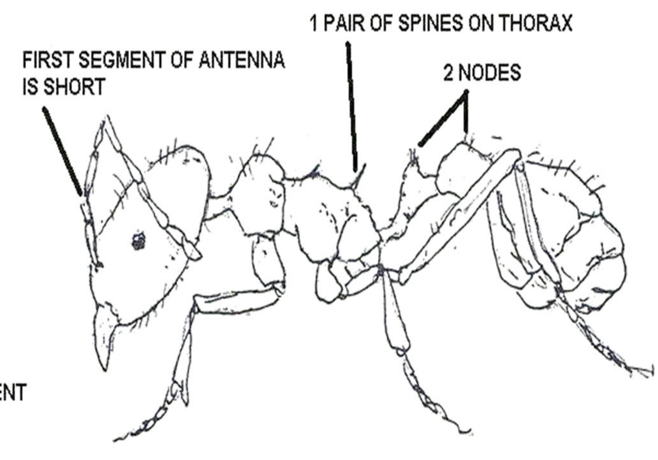


RED FIRE ANT



PAVEMENT ANT

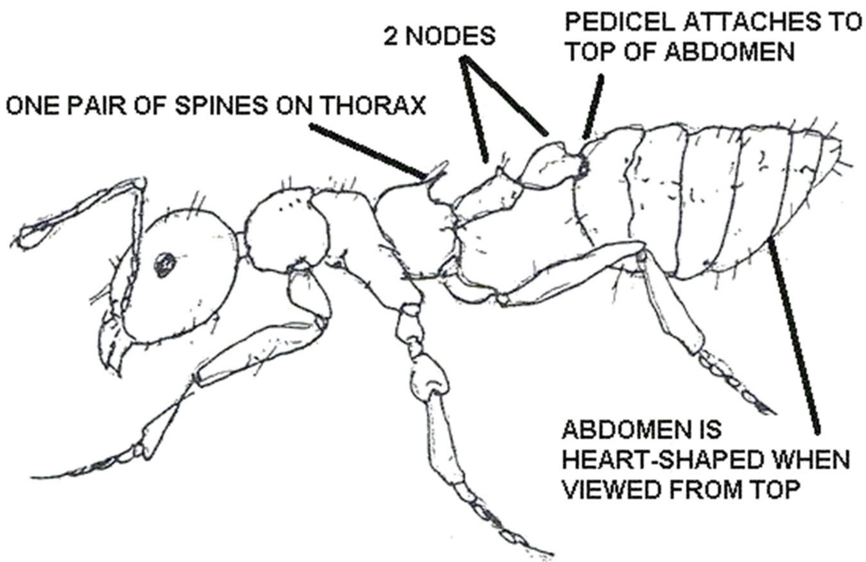
(Pheidole spp.)



BIG-HEADED ANT

(Pheidole spp.)

Acrobat Ant – 2 Node Ant



ACROBAT ANT (CREMASTOGASTER LINEOLATA)

Acrobat Ants, Crematogaster species (Hymenoptera: Formicidae)
Acrobat ants get their common name from their habit of raising their abdomen over their head and thorax. The workers are known to bite aggressively and to give off a repulsive odor when alarmed. In nature, colonies may nest in exposed soil, under stones, stumps and old trees. They occasionally become pests by invading homes where they are known to nest in woodwork and foam insulation, and infest household foods. They feed on live and dead insects, and they tend aphids for their sugary excrement known as "honeydew." In homes, they show a slight preference for sweets and meats or other high protein foods.

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.
Like all ants, the acrobat ants may produce winged, reproductive individuals (males and females) called swarmers. These sexually developed adults emerge from an established colony, usually in the fall, to disperse and start new colonies. The swarmers are harmless, but they may be the first indication of an infestation. Special treatment of swarmers beyond vacuuming or sweeping them up is not required.

Acrobat ants entering from outdoors can be managed by sealing the exterior cracks through which they enter, using a residual insecticide barrier along the foundation, or by treating the ant nest if the location can be determined through careful inspection and observation. Ant colonies living within the walls should be treated by eliminating any moisture problems (if present) and by injecting household insecticide spray or dust into infested wall voids. It may be necessary to drill small holes to accomplish this treatment. Insecticides containing pyrethroids are available to homeowners for outdoor use. Always follow labeled directs. Please read "Insecticides in the Home Landscape and Garden" for more information. Insecticides for use indoors are in ready-to-use formulations. Visit your local retailer to find a ready-to-use insecticide labeled for ants. Read and follow the directions on the label.

Detailed Description: 2.4 mm (1/10 in) (P. megacephala minors) and 3.8 mm (1/7 in) (P. megacephala majors) long. Front half of head sculptured, back half-smooth and shiny. Two-segmented petiole, where postpetiolar node is distinctly broader than long and subangular on each side. Twelve-segmented antennae with three-segmented club. Epinotal spines on propodeum. There are some 15 Pheidole species in Florida. The bilobed head of P. megacephala majors is characteristic. Subfamily Myrmicinae.

Diet: Living and dead insects. Collect honeydew from sap-sucking insects. Forage for sweets, fats, and proteins in homes.

Most Common Complaints: Foragers both inside and outside. Piles of sand and other debris indoors. Outdoor colonies are difficult to control because of multiple nests, so restrict access to buildings. Management includes locating and appropriately treating colonies. Treating using outdoor granular baits may be used, but may not be effective when large colonies are present.

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 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.

Detergent Barrier
Temporary "moats" of detergent and water may be useful during heavy ant invasions.

- Containers of food or food waste which must remain open during working hours can be placed in large, shallow pans filled with water mixed with a small amount of detergent.
- Use this technique to protect potted plants from ants that may be attracted to nectar produced by the plant or to honeydew produced by plant-feeding insects. Elevate the pot above the detergent-and-water mixture by placing it on an overturned saucer. Make sure the limbs and leaves of the plant are not in contact with surfaces that ants could use as bridges.

Chemical Controls
At times, non-chemical methods alone prove insufficient to solve the problem. Integrating a pesticide into your management program may be necessary to gain control of the ant problem. Pesticides must be used in accordance with their EPA-approved label directions.

Applicators must be certified to apply pesticides and should always wear protective equipment during applications. All labels and Safety Data Sheets (SDS) for the pesticide products authorized for use in the IPM program should be maintained on file. Do not apply these materials when buildings are occupied, and never apply them where they might wash into drains or sewers. When treating ants, all baits and dusts should be placed in cracks, crevices, and in precise areas where ants are active.

Detergent and Water
When ants invade a classroom or food preparation area, use a mixture of soap and water in a spray bottle. This mixture will quickly kill the ants which can then be wiped up with a sponge and washed down the drain. Each classroom, cafeteria, and food preparation area should be equipped with such a spray bottle so teachers and staff can safely deal with emergencies.

These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them.

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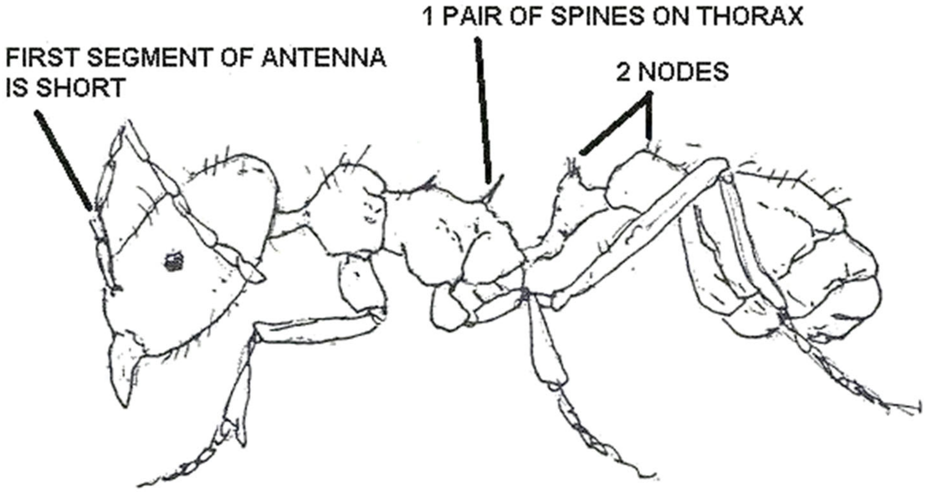
Bigheaded Ant – 2 Nodes



BIG HEADED ANT (PHEIDOLE APP.)

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.

Foraging Characteristics: Small, light brown to reddish brown to nearly black, dull ants. Often foraging in columns. Two worker sizes, although the major (larger, soldier worker) is rare. Majors may appear near baits. Major's head is disproportionately larger than body. No workers intermediate in size will be found. Slow moving. Nest Sites & Characteristics: Nest in soil or under stones, logs, wood, or debris. P. megacephala foraging trails are sometimes soil-covered and resemble subterranean termite foraging tubes. Multiple queens. P. megacephala colonies can be spread out into megacolonies.

Habits
Big-headed ants are most common in warmer areas of the United States. This ant primarily lives outdoors and only occasionally invades structures.

Colonies have multiple queens and can be very large. Nesting is usually in the soil in protected locations like under rocks, logs, firewood, patio blocks, landscape timbers and more. The ants will also nest in open areas. Big-headed ants will construct mud tubes on foundations, similar to termite tunnels.

Detergent Barrier
Temporary "moats" of detergent and water may be useful during heavy ant invasions.

- Containers of food or food waste which must remain open during working hours can be placed in large, shallow pans filled with water mixed with a small amount of detergent.
- Use this technique to protect potted plants from ants that may be attracted to nectar produced by the plant or to honeydew produced by plant-feeding insects. Elevate the pot

above the detergent-and-water mixture by placing it on an overturned saucer. Make sure the limbs and leaves of the plant are not in contact with surfaces that ants could use as bridges.

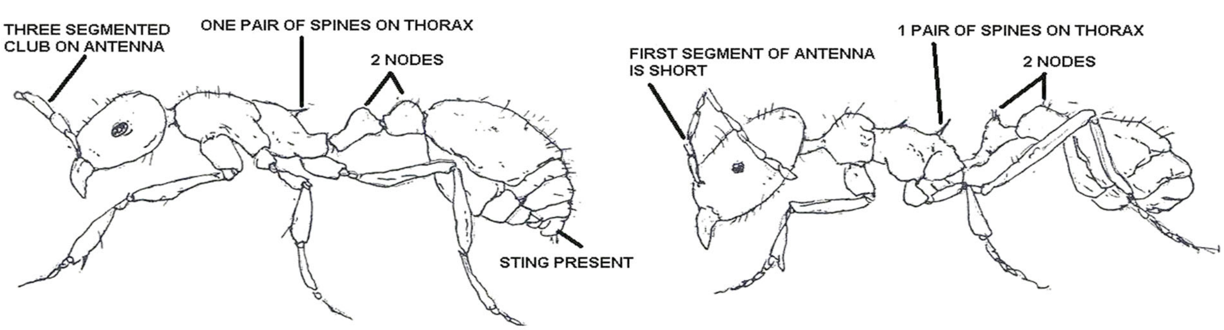
Chemical Controls
At times, non-chemical methods alone prove insufficient to solve the problem. Integrating a pesticide into your management program may be necessary to gain control of the ant problem. Pesticides must be used in accordance with their EPA-approved label directions. Applicators must be certified to apply pesticides and should always wear protective equipment during applications. All labels and Material Safety Data Sheets (MSDS) for the pesticide products authorized for use in the IPM program should be maintained on file. Do not apply these materials when buildings are occupied, and never apply them where they might wash into drains or sewers. When treating ants, all baits and dusts should be placed in cracks, crevices, and in precise areas where ants are active.

Detergent and Water
When ants invade a classroom or food preparation area, use a mixture of soap and water in a spray bottle. This mixture will quickly kill the ants which can then be wiped up with a sponge and washed down the drain. Each classroom, cafeteria, and food preparation area should be equipped with such a spray bottle so teachers and staff can safely deal with emergencies.

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.

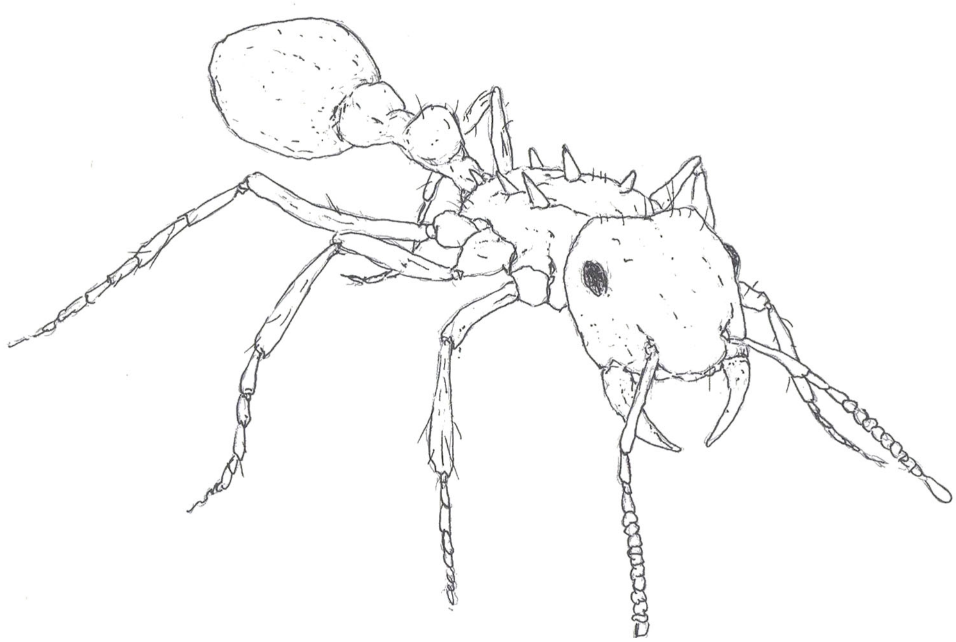
An effective bait is a 99 percent boric acid formulation mixed at a 5 percent concentration by weight in mint apple jelly (about two level tablespoons of powdered boric acid per 10 ounces of mint apple jelly). Another bait is 2 percent boric acid and 98 percent light corn syrup.



PAVEMENT ANT *(Pheidole spp.)*

BIG-HEADED ANT *(Pheidole spp.)*

Leaf Cutter Ants *Atta texana* – 2 Node Ant



LEAF CUTTING ANT

Leafcutter ants, a non-generic name, are any of 47 species of leaf-chewing ants belonging to the two genera *Atta* and *Acromyrmex*. These species of tropical, fungus-growing ants are all endemic to South and Central America and parts of the southern United States.

The *Acromyrmex* and *Atta* ants have much in common anatomically; however, the two can be identified by their external differences. *Atta* ants have three pairs of spines and a smooth exoskeleton on the upper surface of the thorax, while *Acromyrmex* ants have four pairs and a rough exoskeleton.

Next to humans, leafcutter ants form the largest and most complex animal societies on Earth. In a few years, the central mound of their underground nests can grow to more than 98 ft. across, with smaller, radiating mounds extending out to a radius of 260 ft., taking up 320 to 6,500 sq. ft. and containing eight million individuals.

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.

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.

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.

Little Black Ant

Little Black Ant
The scientific name of the little black ant is *monomorium minimum*. Little black ants are small and dark brown, black or jet-black in color. Little black ants are a native species found throughout the United States, with concentrations in thought-out areas of the US. Worker little black ants can be as small as one millimeter in length, and queens can measure up to four millimeters. Their antennae consist of twelve segments and end in a three-segmented club. Their pedicel is two-segmented. Little black ants have no spines and their bodies are unevenly rounded. Although little black ants bear a stinger, it is too small to be effective against most threats. Both males and queens have wings before mating season, though males die soon after mating and females shed their wings. Little black ants prefer meat, but they are omnivorous and will eat insects, sweets, honeydew, vegetables, grease or oily foods, corn meals and plant secretions as well. Little black ant workers forage in trails, which are frequently seen along sidewalks and foundation walls.

Proverbs 6:6-8
A Lesson from the Ant
6-11 You lazy fool, look at an ant. Watch it closely; let it teach you a thing or two. Nobody has to tell it what to do. All summer it stores up food; at harvest it stockpiles provisions.

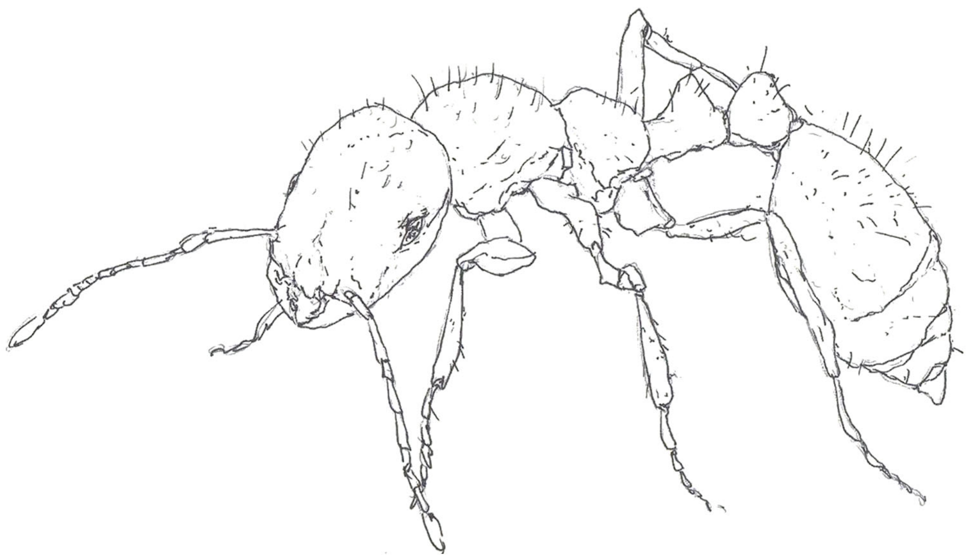
So how long are you going to laze around doing nothing?

How long before you get out of bed?

A nap here, a nap there, a day off here, a day off there, sit back, take it easy—do you know what comes next? Just this: You can look forward to a dirt-poor life, poverty your permanent houseguest!

These little black ants are awesome workers. These ants carried a small lizard twenty feet to their nest within 1 hour. They worked together and overcame all obstacles. One obstacle was carrying the lizard over gravel. Ants waited and gathered more workers and carried the lizard to the nest. They did not bite or tear the flesh but kept the body together. Incredible work effort!

Little Black Ant Identification and Control – 2 Node Ant
Monomorium minimum



LITTLE BLACK 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.

The Little Black Ant is found throughout the US especially the Eastern half of the US and southern California. They get their name from their size and jet black color. The workers are only 1/16 of an inch and the queen is twice that size at 1/8 of an inch. They have a 12 segment antenna with a 3 segmented-club. Little Black Ants have 2 nodes and a small weak stinger.

Swarmers are usually found from June to August when mating and new colonies are formed. The colonies have multiple queens which aids the colonies to grow rapidly. Closely related to the Pharaoh ant in identification except the color, the Little Black Ant is also often mistaken for another ant pest: the Rover Ant.

The Little Black Ant (Monomorium minimum) is a species of ant. Members of the species are tiny and shiny black in color. These ants are pests that are usually found outdoors or in wood inside a home that causes it to decay. Workers are 1/16 inch in length and the queens are 1/8 inch in length. They use recruitment to deal more effectively with large prey. They form colonies with multiple queens.

Ants give birth to live pupa. Ant pupa laid by the queen can take just 10 days to mature. Winged ants may fly away and start a new colony if the current colony is overpopulated. The little black ant nests inside and outside. Outside they prefer decade wood but will also nest under rocks, lawns and also in open areas. Inside they can be found in wood work voids and cracks in cement and under edges of carpet. Their nests can be located by small caters of fine soil deposited at the entrance. Colonies are very mobile and are willing to move if disturbed.

When foraging, little black ants leave a scent mark trail along the edges of structures such as walls, sidewalks or baseboards. These trails can be followed to the nest for baiting or trenching the mounds. The ants will feed on honeydew, grease, oil, meats, fruits, vegetables and sweets. Indoor ant infestations are not typically the result of indoor colonies.

Usually the ants are nesting outside and coming in to the house or building to forage for food. In that case, drenching the exterior mounds with an insecticide such as Cypermethrin can often be the most important step in achieving control.

When mounds cannot be located, spraying the window seals and cracks with Cypermethrin (Cynoff EC, Cynoff WP, Demon WP or Demon WP) and using a sweet bait or dual bait such as Gourmet or Advance Dual Choice in the house is a great combination. NEVER use an indoor spray if you are incorporating the use of an indoor ant bait! Such tactics will usually contaminate your bait, resulting in failure to control the pests.

Simply picking up rocks and debris around the house will also help. If the ants are nesting in the house, the wall voids will need to be dusted with Drione in areas where ant baits are not to be used. Ant infestation 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.

In general, ant baits can be found as:

- Granules for broadcast
- Liquids
- Gels
- Ready-to-use, tamper resistant containers

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.

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).

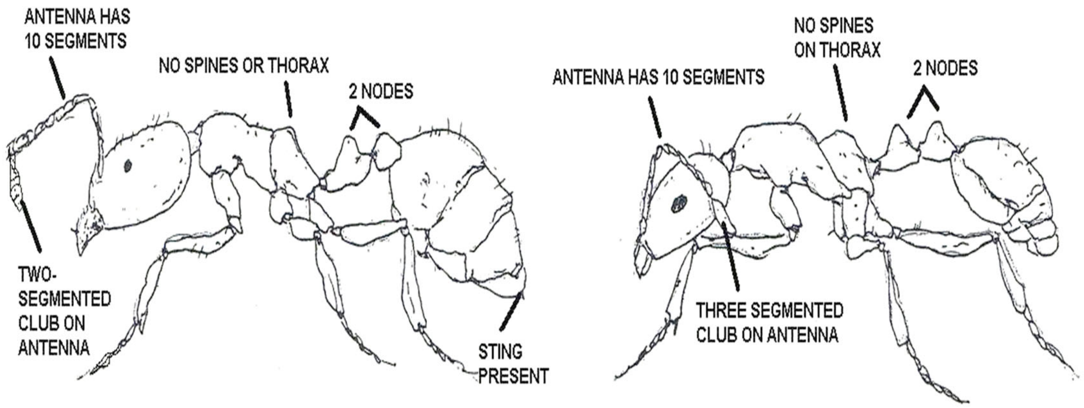
The Recommended Products for the Protein/Grease Eating Cycle Would Be:
- Maxforce Ant Bait Stations
- Flourguard Ant Bait Stations
- Maxforce Ant Granulars
- Advance Carpenter Ant Bait

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.



THIEF ANT
(Solenopsis molesta)

PHARAOH ANT
(Monomorium pharaonis)

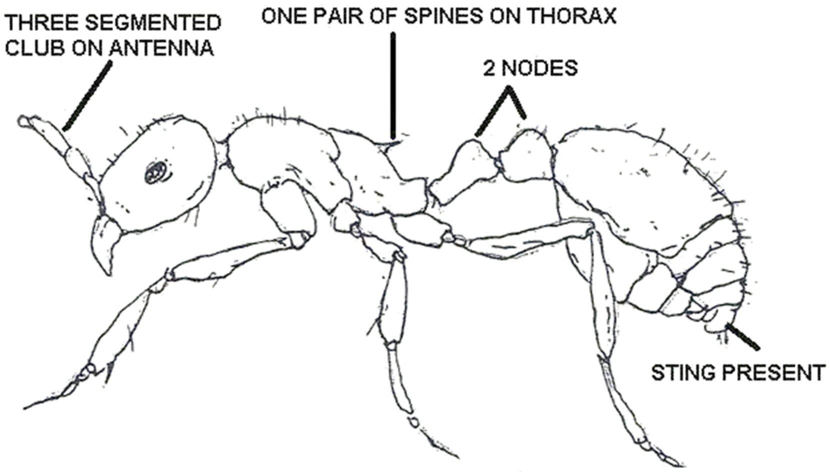
Key Words

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.

Pavement Ant *Tetramorium caespitum* – 2 Node Ant



PAVEMENT ANT
(Pheidole spp.)

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.

Detergent Barrier
Temporary "moats" of detergent and water may be useful during heavy ant invasions.

- Containers of food or food waste which must remain open during working hours can be placed in large, shallow pans filled with water mixed with a small amount of detergent.
- Use this technique to protect potted plants from ants that may be attracted to nectar produced by the plant or to honeydew produced by plant-feeding insects. Elevate the pot above the detergent-and-water mixture by placing it on an overturned saucer. Make sure the limbs and leaves of the plant are not in contact with surfaces that ants could use as bridges.

Chemical Controls
At times, non-chemical methods alone prove insufficient to solve the problem. Integrating a pesticide into your management program may be necessary to gain control of the ant problem. Pesticides must be used in accordance with their EPA-approved label directions. Applicators must be certified to apply pesticides and should always wear protective equipment during applications. All labels and Safety Data Sheets (SDS) for the pesticide products authorized for use in the IPM

program should be maintained on file. Do not apply these materials when buildings are occupied, and never apply them where they might wash into drains or sewers. When treating ants, all baits and dusts should be placed in cracks, crevices, and in precise areas where ants are active.

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).

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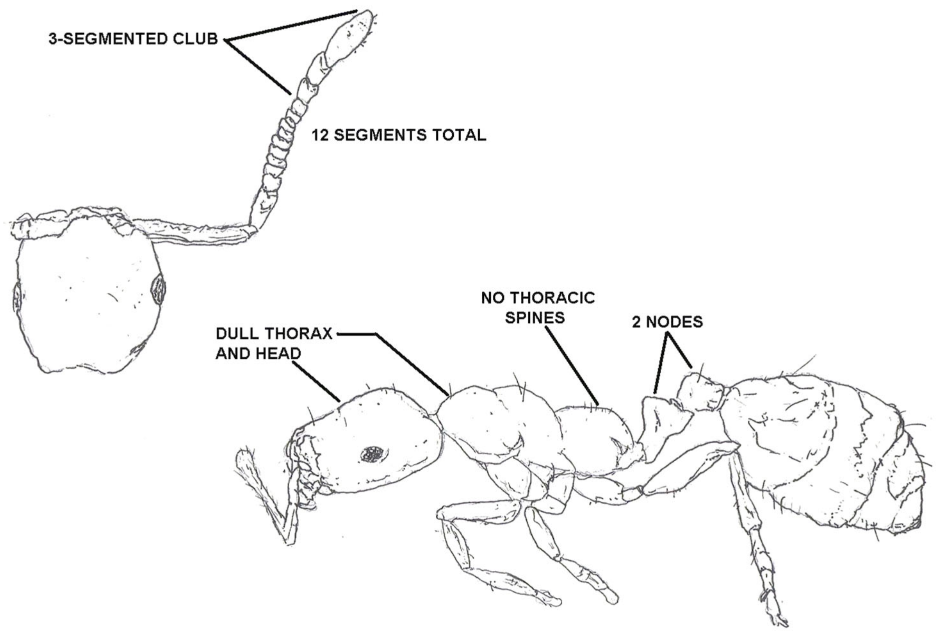
Methoprene
A commercial bait called methoprene (Pharorid) is marketed for use by pest control operators in a bait that consists of liver, honey, and sponge cake. It is often difficult to use the bait ants prefer; as ants feed on one compound, another compound placed less than 1/4-inch away will be ignored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

Pharaoh Ant *Monomorium pharaonis* – 2 Node Ant



PHARAOH ANT

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.

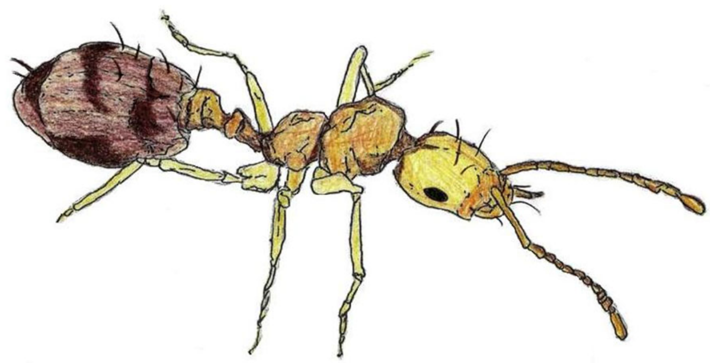
Life Cycle and Habits

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.

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.

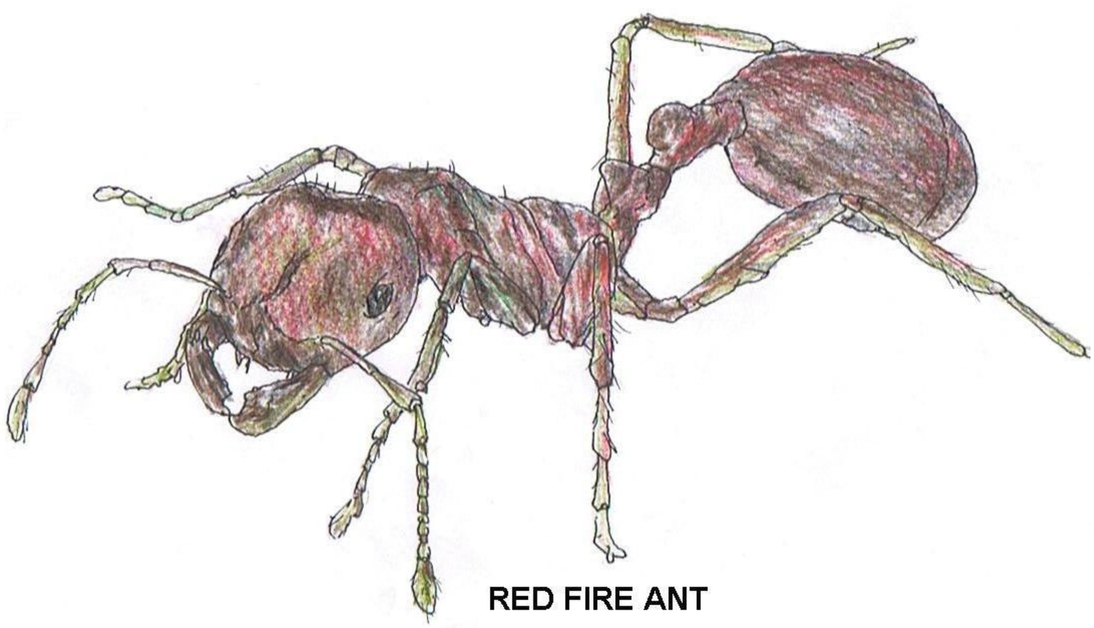
Usually, Pharaoh ant control is best achieved by a licensed pest control operator or applicator who is trained, experienced, and has the proper equipment--an Applicator like yourself. Before using an insecticide, always read the label, follow directions and safety precautions.

Red Imported Fire Ants RIFA *Solenopsis invicta* – 2 Node Ant

At one time Red imported fire ants (RIFA) seemed to be only in the South or in Texas, but somehow have moved to New Mexico, then Arizona and now in California. These incredible creatures 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 in 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.

Using Baits Don't Seem to Work
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.

Ant Control - Prevention and Elimination Sub-Section

Prevention is the best line of defense against the establishment of any pest insect. Relatively small ants, such as the white-footed ant can fit through extremely small openings to gain access into the home. If these entry points can be located, they can be blocked by application of caulk or some other exclusion device. This can also help to prevent other insects from gaining access into your home.

Control Strategies
There are two categories of ants that will be encountered with an ant problem. The control strategy that you should take depends on your type of infestation. Ants that live outside and forage in the home.

Ants that live outside will travel inside the home to search for food. Some species may ultimately reside in houses, discussed later in this fact sheet. 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.

Specific Actions
If the nest is exposed (e.g. due to remodeling or reroofing) you can use a liquid or aerosol ready-to-use insecticide, such as bifenthrin, cyfluthrin, deltamethrin, or permethrin. Spray the insecticide directly into as much of the nest as possible. The more of the colony that is exposed, the better your chance of destroying it. It is necessary to anticipate an ant colony and have a product ready at the start of construction. Once the nest is exposed, that portion of the colony will try to relocate to protect themselves.

Sprays on surfaces where ants travel or congregate, such as along baseboards or in holes or cracks in the walls and floors, may reduce the frequency and number of ants you see. However, they are not effective in eliminating a nest because 1) the ants carry very little insecticide back to their nests and 2) most ants forage outside and do not come in contact with the insecticides. Be aware of the potential for more than one nest in a building, but only treat nests that you know exist. Do not treat areas of a building if additional nests are not found.

Once a carpenter ant nest is treated, continue to watch for evidence of an active nest until the following spring. If no evidence is observed, then further insecticide applications are unnecessary.

What to Do If You Have an Ant Emergency
Baits take time to work so continue to clean up trails.

- Determine what the ants are attracted to and remove the food source.
- Indoor sprays are not usually necessary.
- Put out bait stations or apply gel bait at entry points.
- Vacuum trails, wipe them with soapy water, or spray with window cleaner.
- Locate entry points and caulk openings or plug with petroleum jelly

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

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.

Ant Bait Treatments

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, 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.

If the nest cannot be located, baits may be an effective alternative. Baits work by combining an attractive food source with a slow-acting toxicant. A delayed toxicant is critical because it allows the ants to forage normally for days or even weeks. During that time, ants consume the bait and return to the nest to share the bait with the rest of the colony. In a process known as trophallaxis, one ant regurgitates its stomach contents to another ant. This food sharing behavior enables the bait to be spread throughout the colony before the toxicant takes effect.

There are a few baits available to nonprofessionals for carpenter ant control. Most retail products are liquid or granular formulations containing hydramethylnon, sulfluramid, abamectin, or boric acid. An inexpensive liquid bait of 1% boric acid in a 10% sugar water solution can be mixed at home, but it is very slow acting and must be constantly replenished. Baits vary a great deal in their effectiveness. Carpenter ants have complex food preferences, and some of the sugar-based baits will not be attractive to the ants long enough to be successful.

Outdoors
Often carpenter ant nests found indoors are satellite nests that can be traced back to a parent colony outdoors in trees, stumps, roots, fence posts, landscape timbers, and other wood structures. When possible, remove wood that contains carpenter ant nests, or destroy the colony. When this is not practical, and carpenter ants are discovered entering your customer's home from outdoor nests, a treatment with a residual insecticide around the building's exterior helps keep them out of the home. As before, be sure the product you intend to use is labeled for use around building exteriors.

Products, such as bifenthrin, cyfluthrin, or permethrin, are also available to homeowners. Only professional pest control services should treat the home's exterior.

Spray the product in a band, covering the foundation and under the lower edge of the siding to help keep ants from coming inside. Trim branches that overhang buildings or electrical wiring to avoid giving carpenter ants easy access to your home. Note: Be sure the tree or shrub species can be pruned at the time you wish, e.g. do not prune oak between April 15 and September 15 because of the risk of oak wilt. Treating the building's exterior is a short term control measure. A permanent control method is to eliminate or remove the nest. If this cannot be done directly, then use baits to eradicate the outdoor colony.

Pesticide Treatments General Applications
Chemical Control. Ants can be controlled with baits, crack and crevice treatments, indoor space and surface treatments, outdoor barrier and broadcast treatments, as well as void and attic treatments.

However, methods that target individual trails of ants such as crack and crevice treatments and indoor space and surface treatments are usually a "quick fix" and ineffective in the long term because they do not significantly reduce the ant population and do not affect the queen. Ant baits, however, were developed to exploit the foraging and nest mate feeding behaviors of ants. Bait treatments are effective for control of many ant species and are available in homeowner and professional product versions.

Since ants rely heavily on trophallaxis (reciprocal feeding), the bait toxicant can be thoroughly distributed to the members of the colony, including the queen and brood. Baits are effective because they not only kill the foraging members of the colony, but they kill the queen(s) so no other ants are produced. The ideal bait contains a slow-acting, non-repellent toxicant that is incorporated into a preferred food substrate. There are many types of baits on the market.

Some baits contain:

- Insect growth regulators that primarily impact brood production and development (Extinguish, Award, Distance, etc.)
- Metabolic inhibitors that primarily kill the foraging workers, the brood and queen (Amdro, Combat, etc.)

In general, ant baits can be found as:

- Granules for broadcast
- Liquids
- Gels
- Ready-to-use, tamper resistant containers

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.

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.

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.

Specific and General Ant Treatment Chemicals/Products and Applications
TERMIDOR is a wonderful pesticide for ant control but is not designed for ants but for termites only. This unique formulation is slow acting and as ants travel over surface areas, they'll be picking up a dose of active that will eventually spread throughout their nest. Within 4-8 days, it will effectively shut down any nests it's carried to making it both effective yet easy to use without knowing where the nests are located. But if you can see where the nest is located, a direct treatment with the DRIONE will be fast and immediate. TLC does not like to select trade names or specific products but these are commonly found pesticides and we have examined the control effects in our field studies. If you have a pesticide product and would us to list it or modify information on the following products, please contact us and we will be glad to test, list, or modify your product's information. This information does change and we want to provide the best possible information.

For the Protein and Grease feeding cycles:
- ✓ Advance375 A Ant Bait (for protein/grease feeding cycles)
- ✓ Maxforce Ant Bait Stations (for protein/grease feeding cycles)
- ✓ Maxforce Bait Granulars (for protein/grease feeding cycles)

Sweet Feeding Cycles:
- ✓ Intice Gelanimo Ant Bait for sweet cycles-not messy, particularly good for Odorous Ants
- ✓ Optigard Ant Bait Gel (for sugar feeding cycles excludes fire, harvester and pharaoh ants)

The powerful, slow acting non-repellent active ingredient, thiamethoxam in Optigard ant gel knocks out workers, brood and queens. Also, Optigard Ant Gel Bait provides a longer window of palatability so, as it ages, ants will continue to feed on the bait without any loss of attraction.
- ✓ Maxforce Ant Killer Ant Bait Gel (for sweet feeding cycles)

Nest Treatments

Unless you can treat the nest directly, spraying is not an effective solution for small ants, unless you use a non-repellent insecticides or "undetectable" liquid treatments such as Dominion 2L, Termidor or Phantom. Phantom liquid of aerosol is labeled for the inside. Optigard Flex is another very good non-repellent labeled for inside for many types of ants.
Dominion 2L and Termidor may not be used inside. Unlike older insecticides, non- repellent insecticides can't be smelled, tasted, or even felt by pests. So they crawl through the treated area, not knowing that by ingesting treated materials or merely contacting the insecticide, they'll die.

Again, workers must eat the bait, take it back to the nest, and feed to the queen and larval ants. This type of control is incompatible with treatments (such as repellent sprays) that prevent workers from returning to the nest with the bait.

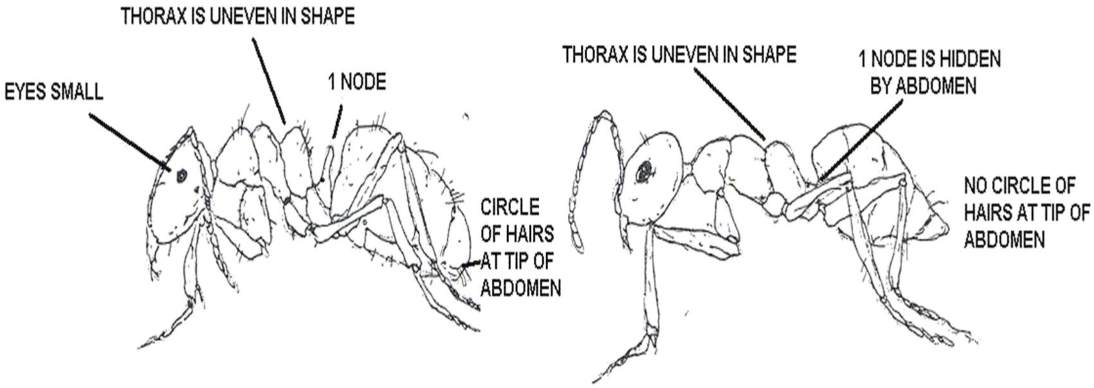
Unlike other home-inhabiting ants, the larger carpenter ants cause structural damage to wood by excavating and nesting inside wood structures. Carpenter ants usually do not make nest in healthy wood, but tunnel wood that has become wet and started to decay. The larger Carpenter ants are about 3/8 to 1/2" long. They may be black or red.

One effective method to treat carpenter ants are either by baiting, placing the recommended carpenter ant baits listed below one their trails or the use of a non-repellent insecticide inside called Phantom Liquid or Phantom Aerosol or equivalent chemical.

Carpenter ants are most active in the evening hours foraging for food, both inside the house and outside. By following ants at that time, you may be able to tell where to spray or bait. Treating the carpenter ant nest directly would be the last resort for carpenter ants, as there is a tendency to scatter the colony if you do not treat the nest entirely.

Ant Baits recommended for the Larger Carpenter Ants:(Sugar and Protein Feeding Cycles)-When in doubt of which one to choose, choose one from each category

- ✓ Advance 375 A and Maxforce Carpenter Ant Bait Gel are excellent baits for the larger carpenter ants, when used together they feed both the sugar and protein feeding cycles of these ants. The Advance 375 A feeds the protein needs while the Maxforce Carpenter Ant Bait Gel feeds the sugar requirements of the colony.
- ✓ Advance375 A Ant Bait (for protein/grease feeding cycles)
- ✓ Maxforce Carpenter Ant Gel (for sweet feeding cycles) for carpenter ants are excellent baits.



LARGE YELLOW ANT
(Acanthomyops interjectus)

ODOROUS ANT
(Tapinoma sessile)

USING A FLASHLIGHT TO INDENTIFY PESTS

Carpenter Ant Infestation Prevention

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.

Non-Repellents for Outside Ant Control: Dominion 2L, Termidor and Phantom.
Since Dominion 2L (Same as Premise 2) is a non-repellent, carpenter ants, Pavement Ants and Argentine Ants can't detect it; instead, they come directly in contact with the active ingredient, -imidacloprid, without trailing in another area.

✓ Dominion 2L is much more economical than Termidor, but is only labeled for Carpenter Ants, Argentine and Pavement Ants. Dominion 2L is not labeled for Fire ants, Pharaoh or harvester ants.

✓ Dominion 2L is labeled for outside use only and will yield- 50 gallons (strongest dilution rate) compared to Termidor SC- 12 gallons (strongest dilution rate).

Phantom Insecticide and Phantom Aerosol for Inside and Outside Ant Control:
For Roach and Ant control inside use the non-repellent insecticide product Phantom. Phantom will yield 8 gallons for ant control. It is highly suggested that you use a non-repellent such as Termidor SC for the outside in conjunction with the Phantom

Phantom is extremely effective when used alone, or in conjunction with other products such as ant baits. It will not repel pests, or cause them to avoid bait areas. Phantom treatments only require a small amount applied to problem areas to achieve ant control. Phantom is long-lasting, and effective at controlling entire ant and roach populations at low doses. Phantom provides superior roach and ant control by striking ants inside your home where they cause the most trouble. But if you have an ant problem, the ants in your house probably have their nests outside-they travel back and forth. Phantom Aerosol-Convenient form of Phantom in a ready to use spray

Pyrethroids
The pyrethroids are a large family of modern synthetic insecticides similar to the naturally derived botanical pyrethrins. They are highly repellent to termites, which may contribute to the effectiveness of the termiticide barrier. They have been modified to increase their stability in the natural environment. They are widely used in agriculture, homes, and gardens. Some examples are bifenthrin, cyfluthrin, cypermethrin, deltamethrin, and permethrin. They may be applied alone or in combination with other insecticides.

Pyrethroids are formulated as emusifiable concentrates (EC), wettable powders (WP), granulars (G), and aerosols. Certain pyrethroids exhibit striking neurotoxicity in laboratory animals when administered by intravenous injection, and some are toxic by the oral route. Systemic toxicity by inhalation and dermal absorption are low, however—there have been very few systemic poisonings of humans by pyrethroids. Though limited absorption may account for the low toxicity of some pyrethroids, rapid biodegradation by mammalian liver enzymes (ester hydrolysis and oxidation) is probably the major factor responsible. This publication contains pesticide recommendations that are subject to change at any time.

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

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

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

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

Most pyrethrins and some pyrethroid products are formulated with synergists, such as piperonyl butoxide and MGK-264, to enhance the pesticidal properties of the product. These synergists have no pesticidal effects of their own but enhance the effectiveness of other chemicals.

Pyrethrins, a single pesticide active ingredient, contain six components that have insecticidal activity:
pyrethrin 1, pyrethrin 2, cinerin 1, cinerin 2, jasmolin 1, and jasmolin 2

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 gradual, 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 Gradual, 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 the customer's 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.

Ant Treatment Chemical Usage C/C

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, and 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 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.

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Ant Predators

Ground beetles, humpback flies, parasitic wasps, praying mantis and the yellow-shafted flicker all dine on ants. Woodpeckers are voracious ant eaters. You may see them also pick up ants in their beaks and crush them on their feathers. What are they doing this for? Crushing the ants' bodies releases tannic acid which in turn protects the bird from parasites!

Here is something interesting: it is said if you take a shovelful of ants from one hill or nest and put it in another ant hill then take a shovelful from that hill and put it where you took the first one the ants will then wage war on one another and do themselves in!

Ant Repellent Plants
Catnip, pennyroyal, peppermint, sage, and spearmint. Tansy which is often recommended as an ant repellant may only work on sugar type ants. These are the ones that you see on peonies and marching into the kitchen.

Warning: You do not want to plant Tansy anywhere that livestock can feed on it as it is toxic to many animals. Do not let it go to seed either as it may germinate in livestock fields.

Organic Ant Barriers
Sprinkle leaves and flowers from sage, mints or tansy around the outside of your house or plants that are bothered by ants. These plants can also be used as a living barrier for ant control, bearing in mind that they are invasive in their growth habit and using cuttings from these plants as a barrier is more effective. We grow tansy in an out of the way place to harvest the cuttings.

- Vinegar sprays in and around the hose foundation will repel ants. Keep way from the soil and concrete. Lemon juice concentrate can also be used: mix 50/50 with water and spray.
- Ants will not walk through a line of talcum powder or chalk dust. Diatomaceous earth may also be used as a barrier in and out of the household.
- Using a silica areogel/pyrethrum spray applied to the base of plants like eggplants and peppers can control fire ants from girdling the stems and killing the plants. This is a good barrier as it stays "put."
- Caulk all cracks and crevices in the building to deny them access. Be sure to use high quality pure silicone caulking as these are less likely to shrink or crack once applied.
- Distribute cucumber parings as a repellant. Cucumbers contain a compound known as "trans-2-nonenal" that repels ants as well as cockroaches!
- Try sprinkling some of those instant grits around the nests. See what happens!

For fire ants: We recommend Spinosad or try this: Pour half a cup of Epsom salts into the nest and all around it.

- ✓ Sticky barriers like Tanglefoot make an excellent barrier and can be applied to tree trunks to disrupt the ants from farming of aphids. This procedure will naturally biodegrade itself towards the end of the season. **NOTE**: On young trees with smaller trunks or those with thin bark (aspens, birches etc.) do not apply directly to the bark surface. Instead use some thin fabric tied around the trunk with the sticky stuff applied over this. Remove at the end of the season.
- ✓ On smaller plants a bit of petroleum jelly smeared around the base will stop ants immediately.

Direct Controls

- ✓ Douse the nests with boiling water several times. Cruel and can be effective.
- ✓ Dusts such as Silica Aerogel can last a long time. Their mode of action is to dehydrate the ants. They work slowly and are easy to use in tight areas such as cracks or crevices.
- ✓ Make a strong hot water and hot pepper tea. Use the hottest peppers you can find, finely chop them in a food processor, and mix with hot water. Pour directly on the nest.
- ✓ Repeated flooding of the nest every few days using your garden hose can often be enough to get them to relocate. You must be persistent with this method.
- ✓ Use equal parts of sugar and baking powder. Place around ant infested area and nests.
- ✓ Using a sugar soaked sponge works well for light invasions of ants. Use a large sponge with big holes in it. Soak it in a strong solution of sugar water and place it where you want to catch the ants. Rinse the sponge out every day in a container of soapy water. Fix it up with the sugar water again and repeat as often as necessary.
- ✓ Pour apple cider vinegar down entrance holes to the nest.

Last Resorts

- ✓ Pyrethrum mixed with isopropyl alcohol kills ants on contact. Take 16 ounces of ready to use pyrethrum, mix in 1 tbsp. alcohol. Use this as a drench directly on the active nest. Be careful, some states and labels will not allow this mixture.
- ✓ Boric acid: Mix 1 cup of sugar, 4 teaspoons of boric acid and 24 ounces of water in a glass screw top jar. Shake thoroughly until you can see that all the crystals are dissolved. Now put 1 cup of this mixture into a smaller jar which you have filled halfway with loose cotton. Firmly screw the lid back on, seal around the band with weatherproof tape and using an awl punch a few small holes in the center of the lid. Put this near the entrance of the nest or wherever they have made a path to your house. The key is the ants will get into the jar to eat the sugar and return to the nest and pass it on to the rest of the colony. If you find many dead ants by the jar dilute the solution and try again. With a proper mixture the colony may be destroyed in a few weeks. It does take the destruction of the queen to completely eradicate a colony. Keep this away from kids and pets!

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Signs and Symptoms of Pesticide Poisoning

In closing of this section, it cannot be emphasized more...
Recognizing Signs and Symptoms of Poisoning
Anyone who may become exposed to pesticides should be aware of the signs and symptoms of pesticide poisoning. Prompt action during pesticide overexposure can prevent serious consequences. Poisoning signs can be seen by others, for example, vomiting, sweating, or pin-point pupils.

Even with only mild symptoms, a worker can feel uncomfortable. Eyes can water and get red and itchy. Skin can get red bumps and feel itchy.

- Dizziness, faintness • Blurry vision • Vomiting
- Coughing • Fainting • Very bad headaches
- Wheezing or trouble • Drooling from
- Small pupils breathing mouth or nose of the eyes

Severe Symptoms
Some of these symptoms may feel like a cold, flu, or heat exhaustion. Some people may have an allergic reaction to plants, fertilizers, or other chemicals used in agriculture. It is best to see a doctor if any of these symptoms are present.

Very Severe Pesticide Poisoning Can Lead to Death.

Symptoms

- ✓ Are any functional changes in normal condition that can be described by the victim of poisoning, and may include nausea, headache, weakness, dizziness, and others?
- ✓ Anyone who works with pesticides should learn what these signs and symptoms are to prevent serious injury and allow prompt treatment.

Persons who are frequently involved with pesticides should become familiar with these important steps:

Recognize the signs and symptoms of pesticide poisoning for those pesticides you commonly use or to which you may be exposed.

1. If you suspect a pesticide poisoning, get immediate help from a local hospital, physician, or the nearest poison control center.

2. In a pesticide emergency, identify the pesticide to which the victim was exposed. Provide this information to medical authorities.

3. Have a copy of the pesticide label present when medical attention is begun. The label provides information that will be useful in assisting a pesticide poisoning victim.

4. Know emergency measures you can take until help arrives or the victim can be taken to the hospital. Both first aid and medical treatment procedures are listed on the product label.

Recognizing Common Pesticide Poisonings

All pesticides in a given chemical group generally affect the human body in the same way; however, severity of the effects vary depending on the formulation, concentration, toxicity and route of exposure of the pesticide. It is important, therefore, to know both the type of pesticide you are using and the signs and symptoms associated with poisoning from it.

Signs and Symptoms of Pesticide Poisoning

- ✓ headache, fatigue, dizziness, loss of appetite with nausea, stomach cramps and diarrhea;
- ✓ blurred vision associated with excessive tearing;
- ✓ contracted pupils of the eye;
- ✓ excessive sweating and salivation;
- ✓ slowed heartbeat, often fewer than 50 per minute;
- ✓ rippling of surface muscles just under the skin.

These symptoms may be mistaken for those of flu, heat stroke or heat exhaustion, or upset stomach.

Moderately severe organophosphate and carbamate insecticide poisoning cases exhibit all the signs and symptoms found in mild poisonings, but in addition, the victim:

- ✓ is unable to walk;
- ✓ often complains of chest discomfort and tightness;
- ✓ exhibits marked constriction of the pupils (pinpoint pupils);
- ✓ exhibits muscle twitching;
- ✓ has involuntary urination and bowel movement.

Severe poisonings are indicated by incontinence, unconsciousness and seizures.

The order in which these symptoms appear may vary, depending on how contact is made with the pesticide.

If the product is swallowed, stomach and other abdominal manifestations commonly appear first; if it is absorbed through the skin, gastric and respiratory symptoms tend to appear at the same time.

Fortunately, good antidotes are available for victims of organophosphate or carbamate poisoning at emergency treatment centers, hospitals, and many physicians' offices.

As with all pesticide poisonings, time is extremely critical. If a pesticide is swallowed, obtain prompt medical treatment. If a dermal exposure has occurred, remove contaminated clothing, wash exposed skin and seek medical care.

Remember to ACT quickly:

Ask – Ask other workers if they have experienced the same symptoms.

- If others began feeling sick at the same time and have the same symptoms, then the symptoms may be related to a common pesticide exposure. Symptoms of pesticide exposure usually begin only minutes or hours after the initial contact.

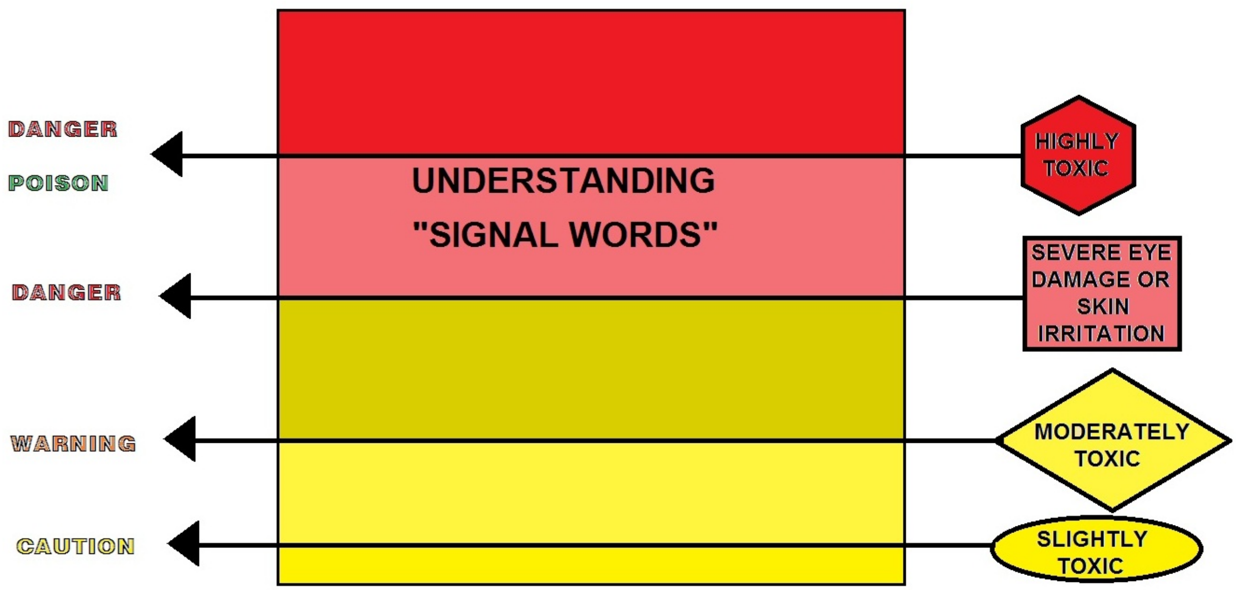
Check – Find out which pesticides were sprayed.

- It is important to know what chemicals were sprayed so your doctor can correctly identify and treat your symptoms. Ask your supervisor or crew leader for this information.

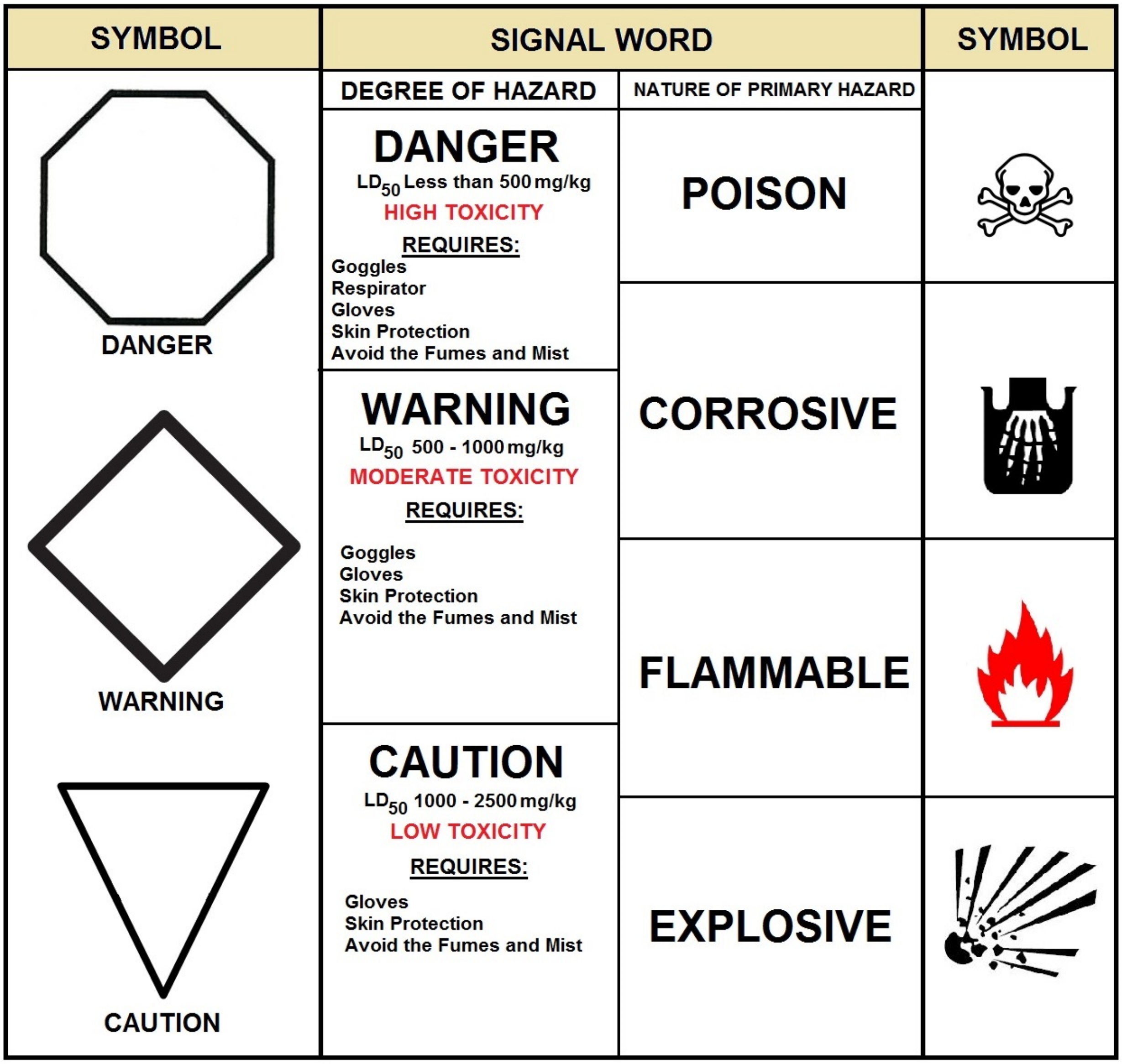
Tell your doctor – Go to a clinic or hospital to seek medical attention.

- If there is even a slight possibility that your symptoms are due to exposure to pesticides, ***tell your doctor this*.**

Note: If you become sick due to hazards at work, you have the right to file a claim for workers' compensation benefits. Your doctor can help you open a claim. These benefits can pay for medical expenses and a portion of wages, if you are too sick to work.



SIGNAL WORDS DIAGRAM



GRAPH DEPICTING DEGREE OF RISK & HAZARD SYMBOLS RELATED TO PESTICIDES

Seeking Medical Attention 1-800-222-1222

If you are having symptoms but are unsure if they are pesticide related, at least notify someone in case your symptoms become worse. Nevertheless, when symptoms appear after contact with pesticides, you should seek medical attention immediately. At this time, call the **National Poison Center at 1-800-222-1222** for guidance on the proper response to your symptoms. This number will direct your call to the nearest poison center, which is staffed on a 24-hour basis.

Emergency First Aid for Pesticide Injuries

Call a Doctor
First Aid is the initial effort to help a victim while medical help is on the way. Step one in any poisoning emergency is to call an ambulance or doctor. The only exception is when you are all alone with the victim. Then you must see that he is breathing and that he is not further exposed before leaving him to make your phone call. Always save the pesticide and label for the doctor.

While Waiting
Do This for:
Poison on the Skin

- The faster the poison is washed off the patient, the less injury that will result.
- Drench skin and clothing with water (shower, hose, faucet, pond).
- Remove clothing.
- Cleanse skin and hair thoroughly with soap and water. Detergents and commercial cleansers are better than soap.
- Dry and wrap in a blanket.

WARNING: Do not allow any pesticide to get on you while you are helping the victim.

Chemical Burns of the Skin

- Wash with large quantities of slow running water.
- Remove contaminated clothing.
- Immediately cover loosely with a clean, soft cloth.
- Avoid use of ointments, greases, powders, and other drugs in first aid treatment of burns.
- Recognize the signs of pesticide poisoning and know first aid treatment for it.
- Know the importance of a pesticide first aid kit and what it should contain.
- Understand the importance of poison control centers and how to get immediate information on types of poisonings and their treatment.

Poison in the Eye

- It is most important to wash the eye out quickly but as gently as possible.
- Hold eyelids open and wash eye with a gentle stream of clean running water.
- Continue washing for fifteen minutes or more. It is important to use a large volume of water. If possible, at least five gallons should be used to flush the eye properly.
- Do not use chemicals or drugs in wash water. They may increase the extent of the injury.
- Cover the eye with a clean piece of cloth and seek medical attention immediately.

Inhaled Poisons (dusts, vapors, gases)

- If victim is in an enclosed space, do not go in after him unless you are wearing an air-supplied respirator.
- Carry patient (do not let him walk) to fresh air immediately.
- Open all doors and windows.
- Loosen all tight clothing.
- Apply artificial respiration if breathing has stopped or is irregular.
- Keep victim as quiet as possible.

- If victim is convulsing, watch his breathing and protect him from falling and striking his head. Keep his chin up so his air passage will remain free for breathing.
- Prevent chilling (wrap patient in blankets but don't overheat).
- Do not give the victim alcohol in any form.

Swallowed Poisons -- When should you make the victim vomit?
The most important choice you have to make when aiding a person who has swallowed a pesticide, is whether or not to make him vomit. The decision must be made quickly and accurately, by a health care professional because the victim's life may depend on it. Usually it is best to get rid of the swallowed poison fast ...
But you should know this:

- **Never** induce vomiting if the victim is unconscious or is having convulsions. The victim could choke to death on the vomitus.
- **Never** induce vomiting if the victim has swallowed a corrosive poison. Find out what poison the person has ingested. A corrosive poison is strong acid or alkali. The victim will complain of severe pain and will show signs of severe mouth and throat burns. A corrosive poison will burn the throat and mouth as severely coming up as it did going down. Dilute the poison as quickly as possible. For acids or alkalis, use milk or water. For patients one to five years old, use one to two cups; for patients five years and older, use up to one quart. For acids, milk of magnesia may also be used (two tablespoons in one cup of water).
- **Never** induce vomiting if the person has swallowed petroleum products such as kerosene, gasoline, oil, or lighter fluid. Most pesticides which come in liquid formulations are dissolved in petroleum products. The words "emulsifiable concentrate" or "solution" on the pesticide label are signals **NOT** to induce vomiting in the poison victim if he has swallowed the concentrates. Concentrated petroleum products (like corrosive poisons) cause severe burns. They will burn as severely when vomited up. If he has swallowed a dilute form of these formulations, he should be forced to vomit immediately.

How to Induce Vomiting
Do not waste a lot of time inducing vomiting. Use it only as first aid until you can get the victim to a hospital. Make sure the victim is lying face down or kneeling forward while retching or vomiting. Do not let him lie on his back, because vomitus could enter the lungs and do more damage.

- First give the patient large doses of milk or water. One to two cups for victims up to five years old; up to a quart for victims five years and older.
- If victim is alert and respiration is not depressed, give syrup of ipecac followed by one to two glasses of water to induce vomiting. Adults (twelve years and over): 30 ml (two tablespoons); children under twelve years: 15 ml (one tablespoon). Activity hastens the effect of the syrup of ipecac.
- Collect some of the vomitus for the doctor may need it for chemical tests.

The best first aid is to dilute the poison as quickly as possible with milk or preferably with water. It is very important that the victim get to the hospital without delay. Many communities have rescue units with ambulances manned by Emergency Medical Technicians who can communicate with the hospital and can begin treatment in route.

If a rescue unit is not available in your area, you will have to transport the patient. Call the hospital emergency room or poison control center for instructions so that they can prepare for the victim's arrival. If the poison control center agrees, use activated charcoal as a "sponge" to absorb excess poisons after the instructions for corrosive or noncorrosive poisons are followed.

- Activated charcoal it absorbs many poisons at a high rate. Mix it with water into a thick syrup for the victim to drink. Activated charcoal is available from a drug store.
- Atropine tablets should not be taken in a poisoning emergency. The dose is much too small. Often the victim cannot or should not take oral medicine. The atropine can hide or delay early symptoms of poisoning. The victim may be fooled into thinking he is okay and may even go back to work. It is possible that a doctor may not detect the problem because the symptoms are hidden by the atropine.

WARNING: Atropine can be poisonous if misused. It should never be used to prevent poisoning. Workers should not carry atropine for first aid purposes. It should be given only under a doctor's directions.

Shock
Sometimes poisoning victims go into shock. If untreated or ignored, the victim can die from shock even if the poisoning injuries would not be fatal.

Symptoms

- The skin will be pale, moist, cold and clammy. The eyes are vacant and lackluster with dilated pupils. The breathing will be shallow and irregular. The pulse is very weak, rapid and irregular. The victim may be unconscious or in a faint.
- Unless he is vomiting, keep the victim flat on his back with his legs up
- 1-1 1/2 feet above his head.
- Keep the victim warm enough to prevent shivering. Do not overheat.
- Keep the victim quiet and reassure him often.

WARNING: Never try to give anything orally to an unconscious victim.
Poison Control Centers
Poison control centers have been established to give pertinent information on all types of poisonings, including pesticide poisoning. The applicator should have posted near his phone the telephone number of the nearest poison control center, and his doctor should also have the number available.

Seeking Medical Attention
1-800-222-1222

EACH PESTICIDE HANDLER EMPLOYEE MUST HAVE AN UNDERSTANDING OF THE FOLLOWING SUBJECT AREAS TO SAFELY USE AND HANDLE PESTICIDES:

PESTICIDE PRODUCT LABELING - Format and meaning of information, such as the precautionary statements concerning human health hazards.

HAZARDS OF PESTICIDES - These are identified in product labeling, Safety Data Sheets (SDS), or PSIS Leaflet (Pesticide Safety Information Series).

PESTICIDE SAFETY REQUIREMENTS AND PROCEDURES - This in regards to regulation, PSIS Leaflets, SDS, Including Engineering Controls, for handling, transporting, storing and disposal of Pesticides.

ENVIRONMENTAL CONCERNS - This addressess the aspect of drift, runoff, and the hazards to Wildlife.

ROUTES OF ENTRY - This area addressess the hazards of which Pesticides can enter the body: Dermal (skin) , Oral (swallowed), Inhalation (breathe in), Ocular (through the eyes).

COMMON SIGNS AND SYMPTOM OF EXPOSURE - Some of the basic symptoms include: Headache, fatigue, weakness, nervousness, nausea, perspiration, eye and skin irritation.

EMERGENCY FIRST AID - Know and understand the basic procedures necessary for first aid concerning exposure to pesticides. This may include basic CPR.

USE AND CARE OF PERSONAL PROTECTIVE EQUIPMENT - Each employee who handles or may have the chance of being exposed to pesticides must have required Personal Protective Equipment available, and each employee must know and understand the proper use and care of this equipment.

THE ITEMS LISTED ABOVE ARE JUST BASICS REQUIRED TO SAFELY HANDLE PESTICIDES

HANDLING PESTICIDE SAFELY DIAGRAM

Routine - Emergency Decontamination Procedures

Routine decontamination procedures are things you can do on a daily basis to protect your health and minimize your exposure to pesticides. Wash your hands before eating, drinking, smoking, chewing gum or tobacco, or using the toilet. Wash your hands before touching your eyes or mouth. Wash your hands even if you have been wearing gloves.

Shower or bathe with soap and water immediately after work. Shampoo your hair and put on clean clothes. Also keep your dirty work clothes away from non-work clothes and the family laundry.

Wash your work clothes separately from other clothes before wearing them again. Routine decontamination procedures may help prevent the need for emergency decontamination procedures.

Emergency decontamination should be initiated if a pesticide is spilled or sprayed on your clothing or skin. Stop work and leaving the work area.

Remove the pesticide contaminated clothing right away and wash immediately in the nearest clean water.

Wash the skin with lots of clean water and soap to prevent the pesticide from being absorbed through the skin and into the body.

Your supervisor or others who are involved in the decontamination process should protect themselves from exposure before they assist you. If medical attention is not necessary, shower, shampoo, and change into clean clothes before resuming work.

Eye Flushing Procedure
To quickly decontaminate your eyes, use an eyewash fountain or pour water into your eyes, holding the eye open while flushing the pesticide out. Move your eyeball and eyelid and flush for at least 15 minutes. Get medical help immediately.

You will be provided with an ample supply of soap, water, and clean towels for both routine washing and emergency decontamination if the areas where you work have had pesticides applied in at least the last 30 days.

These supplies will be located within ¼ mile of where you are working.

§170.509 Decontamination and Eye Flushing Supplies for Handlers

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

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

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

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

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

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

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

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

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

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

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

If Pesticides Are Spilled on the Body

If pesticides are spilled or sprayed on the body to use decontamination supplies to wash immediately or rinse off in the nearest clean water including streams, springs, lakes, or other sources if they are more readily available than decontamination supplies…

What should I do if I am exposed to a pesticide?
1. Minimize further exposure.
• If a pesticide is splashed on your clothing remove the clothes as soon as possible and later wash the clothes separately from other clothes.
• If pesticides are on your skin wash with soap and water for at least 15 minutes.
• For pesticides in the eyes, rinse your eyes with water for at least 15 minutes.
• If you accidentally eat or drink a pesticide, read the label to see if vomiting should be induced. If you feel a burning sensation, rinse your mouth with water and dilute the poison by drinking milk or water.
• If you have inhaled a pesticide, leave the area and seek fresh air. Follow re-entry directions on the product label.
2. If you begin to have symptoms, such as feeling dizzy, having skin irritation/pain, feeling sick to your stomach, or vomiting, call the **Poison Control Center (PCC) at 1-800-222-1222.** The PCC has trained professionals to answer the phone 24 hours a day. They can give information on pesticides and treatment information for those that need it. Help is available in several languages.
3. If advised by the PCC, or if unable to reach a PCC, get medical help from your doctor or hospital emergency room.

Bring with you:
• labels of all pesticides you were exposed to, if available; and/or
• records telling what and how much was sprayed from the person or company that sprayed, if available.

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.

Symptoms of Pesticide Poisoning

You should be aware of the early signs and symptoms of poisoning. It is important to remove the person from the source of exposure quickly. Remove contaminated clothing and wash off any chemical which has soaked through. You may save a life.

PESTICIDE RELATED DERMATITIS

Individuals also vary in their sensitivity to different levels of these chemicals. Some people may show no reaction to an exposure that may cause severe illness in others. Because of potential health concerns, pesticide users and handlers must recognize the common signs and symptoms of pesticide poisoning.

The effects, or symptoms, of pesticide poisoning can be broadly defined as either topical or systemic. Topical effects generally develop at the site of pesticide contact and are a result of either the pesticide's irritant properties (either the active and/or inert ingredient) or an allergic response by the victim.

Dermatitis, or inflammation of the skin, is accepted as the most commonly reported topical effect associated with pesticide exposure. Symptoms of dermatitis range from reddening of the skin to rashes and/or blisters. Some individuals exhibit allergic reactions when using pesticides or when these materials are applied in or around their homes or places of work. Symptoms of allergic reactions range from reddening and itching of the skin and eyes to respiratory discomfort often resembling an asthmatic condition.

Systemic effects are quite different from topical effects. They often occur away from the original point of contact as a result of the pesticide being absorbed into and distributed throughout the body. Systemic effects often include nausea, vomiting, fatigue, headache, and intestinal disorders.

Seeking prompt medical attention is important; however the development of certain symptoms is not always the result of exposure to a pesticide. Common illnesses such as the flu, heat exhaustion or heat stroke, pneumonia, asthma, respiratory and intestinal infections, and even a hangover can cause symptoms similar to pesticide exposure. Carefully consider all possible causes of your symptoms.

Topic 4 - 2 Node Ant Identification and Control Post Quiz

Ant Bait Treatments
1. A delayed toxicant is critical because it allows the ants to forage normally for days or even weeks. During that time, ants consume the bait and return to the nest to share the bait with the rest of the colony.
True or False

2. If the nest cannot be located, baits may be an effective alternative. Baits work by combining an attractive food source with a slow-acting toxicant.
True or False

Key
3. Applied properly and using a fresh bait product, a broadcast application will give _____________ percent control, rarely 100%.

Locate and Treat Colonies
4. Drench colonies living in the soil or under items on the exterior with?

Nest Treatments
5. Dominion 2L and Termidor can be used inside. Like newer insecticides, non- repellent insecticides can be smelled, tasted, or even felt by pests. So they crawl through the treated area, not knowing that by ingesting treated materials or merely contacting the insecticide, they'll die.
True or False

6. Carpenter ants usually do not make nest in healthy wood, but tunnel wood that has become wet and started to decay. The larger Carpenter ants are about 3/8 to 1/2" long. They may be black or red. Unlike other home-inhabiting ants, the larger carpenter ants cause structural damage to wood by excavating and nesting inside wood structures.
True or False

7. One effective method to treat carpenter ants are either by baiting, placing the recommended carpenter ant baits listed below one their trails or the use of a non-repellent insecticide inside called Termidor or equivalent chemical.
True or False

Pesticide Poisoning Symptoms
8. Recognize the ___________________of pesticide poisoning for those pesticides you commonly use or to which you may be exposed.

9. If you suspect a pesticide poisoning, get immediate help from a local hospital, physician, or the?

10. Know emergency measures you can take until help arrives or the victim can be taken to the hospital. Both first aid and medical treatment procedures are listed on the?

Answers

1. True, 2. True, 3. 80% to 90%. 4. Demand, Suspend, or Tempo. 5. False, 6. True, 7. False, 8. Signs and symptoms, 9. Nearest poison control center, 10. Product label

Topic 5 - Wood Preservatives and Insecticides

Topic 5- Section Focus: You will learn the basics of wood preservatives and insecticides. At the end of this section, you will be able to describe products to preserve wood and control wood destroying pests. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Topic 5 – Scope/Background: Some preservatives are classified as "restricted use" by the EPA and these can be used only in certain applications and can be applied only by certified pesticide applicators. Restricted use refers to the chemical preservative and not to the treated wood product. The general consumer may buy and use wood products treated with restricted-use pesticides; EPA does not consider treated wood a toxic substance nor is it regulated as a pesticide. Although treated wood is not regulated as pesticide, there are limitations on how some types of treated wood should be used. Consumer Information Sheets (EPA-approved) are available from retailers of creosote-, pentachlorophenol-, and inorganic-arsenical-treated wood products.

Wood preservatives must meet two broad criteria: (1) They must provide the desired wood protection in the intended end use, and (2) they must do so without presenting unreasonable risks to people or the environment. Because wood preservatives are considered to be a type of pesticide, the U.S. Environmental Protection Agency (EPA) is responsible for their regulation. Federal law requires that before selling or distributing a preservative in the United States, a company must obtain registration from EPA. Before registering a new pesticide or new use for a registered preservative, EPA must first ensure that the preservative can be used with a reasonable certainty of no harm to human health and without posing unreasonable risks to the environment.

To make such determinations, EPA requires more than 100 different scientific studies and tests from applicants. This chapter discusses only wood preservatives registered by the EPA.

This topic section provides information about the preservative and the use and disposal of treated-wood products (see Synopsis of EPA-Approved Consumer Information Sheets for Wood Treated with CCA, ACZA, Creosote, or Pentachlorophenol). The commercial wood treater is bound by the EPA regulation and can treat wood only for an end use that is allowed for that preservative. Some preservatives that are not classified as restricted by EPA are available to the general consumer for non-pressure treatments. It is the responsibility of the end user to apply these preservatives in a manner that is consistent with the EPA-approved labeling. Registration of preservatives is under constant review by the EPA, and a responsible State or Federal agency should be consulted as to the current status of any preservative.

Penta or Pentachlorophenol

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

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

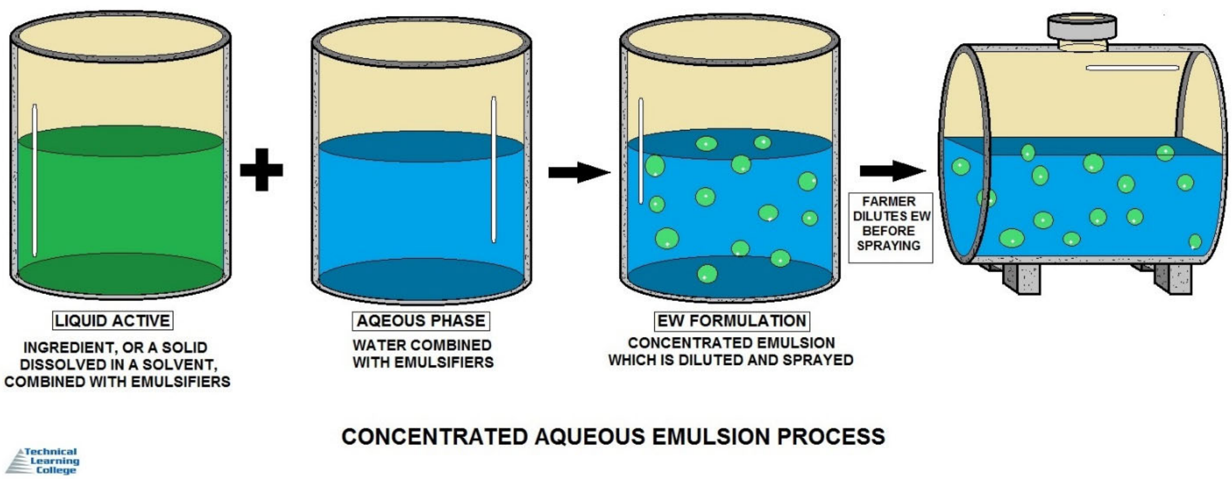
PCP has been detected in surface waters and sediments, rainwater, drinking water, aquatic organisms, soil, and food, as well as in human milk, adipose tissue, and urine. As PCP is generally used for its properties as a biocidal agent, there is considerable concern about adverse ecosystem effects in areas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

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

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

What are the key points for parents and consumers concerned about exposure from structures made of CCA-treated wood?

- ✓ If you are concerned about potential exposure to arsenic, sealants, when applied at least once a year, have been shown to reduce dis-lodgeable arsenic from the wood.
- ✓ Oil or water-based, penetrating sealants or stains are preferred.
- ✓ As always, parents and other caretakers should follow these precautions for children who play on or near decks. Always wash hands thoroughly after contact with treated wood, especially prior to eating and drinking, and ensure that food does not come into direct contact with any treated wood.
- ✓ At this time, we do not believe there is any reason to remove or replace CCA treated structures, including decks and playground equipment, but all the things and laws change like on an everyday basis.
- ✓ Consumers should follow manufacturer recommendations when handling the wood, including the same precautions that workers should take: wear gloves when handling wood, wear goggles and dust masks when sawing and sanding, always wash hands before eating, and never burn CCA treated wood.
- ✓ The majority of exposure that is estimated to occur to children is from hand-to-mouth activities (i.e., children touching the surface of CCA-treated wood and then putting his/her hand in his/her mouth). This activity is most prevalent in children aged 1 to 6 years of age.



Precautions and Personal Protection Measures

Wood treated with modern preservatives is generally safe to handle given appropriate handling precautions and personal protection measures. However, treated wood may present certain hazards in some circumstances such as during combustion or where loose wood dust particles or other fine toxic residues are generated or where treated wood comes into direct contact with food and agriculture.

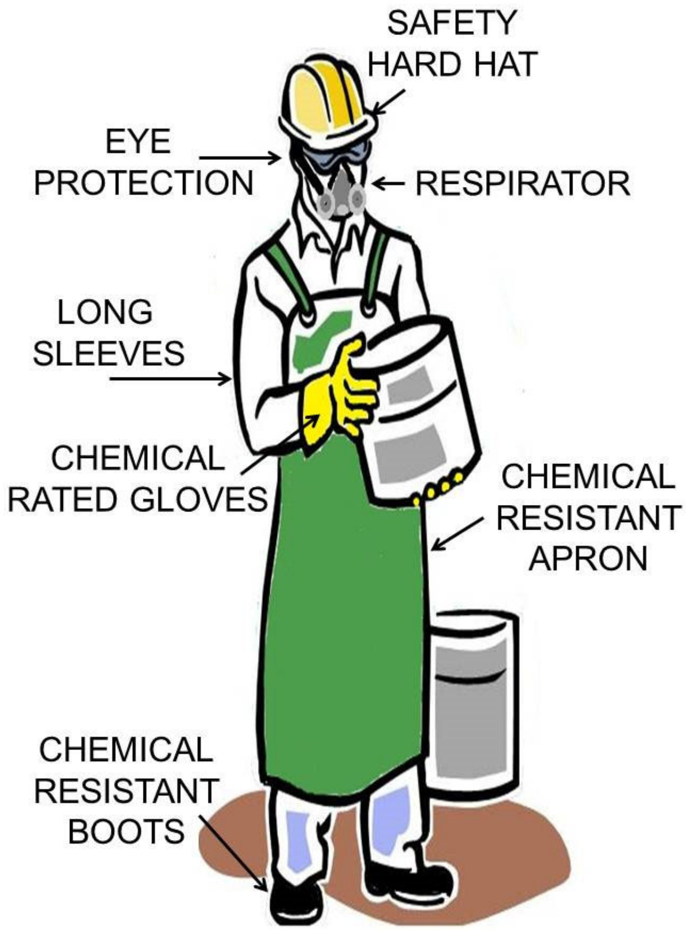
Preservatives containing copper in the form of very small particles have recently been introduced to the market, usually with "micronized" or "micro" trade names and designations such as MCQ or MCA. While the manufacturers represent that these products are safe and EPA has registered these products, some groups have expressed concerns regarding exposure to engineered sub-micron and nano-sized copper particles. These concerns have led to a debate among advocacy groups and governments on whether special regulation of nanotechnology is warranted.

Material safety data sheets and safe handling guidelines are required by law to be provided by suppliers of wood preservative chemicals and treated wood products. This information should be obtained and reviewed before handling and using wood preservative chemicals and treated wood products

Re-Registration Eligibility Decisions (RED)

EPA has completed its re-registration eligibility decisions (RED) for the heavy duty wood preservatives chromated arsenicals, pentachlorophenol, and creosote. In general, EPA has determined that the compounds contribute benefits to society and are eligible for reregistration provided the mitigation measures and associated label changes identified in the REDs are implemented and required data are submitted.

In its risk assessments, the Agency identified risks of concern associated with occupational exposure (i.e., treatment plant workers) to all three preservatives and ecological exposure to pentachlorophenol and creosote.



2017 Changes to EPA's Farm Worker Protection Standard

In late 2015 the Environmental Protection Agency issued the long awaited revision to the Worker Protection Standard (WPS). 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 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.

Chromated Copper Arsenate (CCA)

Chromated copper arsenate (CCA) is a chemical wood preservative containing chromium, copper and arsenic. CCA is used in pressure treated wood to protect wood from rotting due to insects and microbial agents. EPA has classified CCA as a restricted use product, for use only by certified pesticide applicators.

CCA has been used to pressure treat lumber since the 1940s. Since the 1970s, the majority of the wood used in outdoor residential settings has been CCA-treated wood. Pressure treated wood containing CCA is no longer being produced for use in most residential settings, including decks and playsets.

The Agency has completed its reregistration eligibility decision (RED) and will continue to work with stakeholders to implement its decision. Pesticide manufacturers to voluntarily phased out certain CCA use for wood products around the home and in children's play areas. Effective December 31, 2003, no wood treater or manufacturer may treat wood with CCA for residential uses, with certain exceptions.

Timeline for Reregistration/Risk Assessment
September 25, 2008 – Chromated Arsenicals Reregistration Eligibility Decision (RED) signed.
November 19, 2008 – Announce availability of RED in Federal Register.
March 31, 2009 – Updated product labels reflecting mitigation to be submitted to EPA.
December 31, 2013 – All treatment plants to be upgraded to reflect measures outlined in RED.
Synopsis of EPA-approved consumer information sheets for wood treated with CCA, ACZA, creosote, or pentachlorophenol

NOTE: This is only a synopsis of information contained in consumer information sheets. For complete consumer information sheets, contact your treated wood supplier or the website of the Environmental Protection Agency.

Handling Precautions

- Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing, sanding, and machining treated wood, wear a dust mask. Whenever possible, these operations should be performed outdoors to avoid indoor accumulations of airborne sawdust from treated wood. When power-sawing and machining, wear goggles to protect eyes from flying particles. Wear gloves when working with the wood. After working with the wood, and before eating, drinking, toileting, and use of tobacco products, wash exposed areas thoroughly. Avoid frequent or prolonged skin contact with creosote- or pentachlorophenol-treated wood. When handling creosote- or pentachlorophenol-treated wood, wear long-sleeved shirts and long pants and use gloves impervious to the chemicals (for example, gloves that are vinyl coated). Because preservatives or sawdust may accumulate on clothes, they should be laundered before reuse. Wash work clothes separately from other household clothing.
- Treated wood should not be burned in open fires or in stoves, fireplaces, or residential boilers, because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (such as construction sites) may be burned only in commercial or industrial incinerators or boilers in accordance with state and

Federal regulations. CCA-treated wood can be disposed of with regular municipal trash (municipal solid waste, not yard waste) in many areas. However, state or local laws may be stricter than federal requirements. For more information, please contact the waste management agency for your state.

- Use Site Precautions.
- All sawdust and construction debris should be cleaned up and disposed of after construction. Do not use treated wood under circumstances where the preservative may become a component of food or animal feed. Examples of such sites would be use of mulch from recycled arsenic-treated wood, cutting boards, counter tops, animal bedding, and structures or containers for storing animal feed or human food. Only treated wood that is visibly clean and free of surface residue should be used for patios, decks, and walkways. Do not use treated wood for construction of those portions of beehives which may come into contact with honey. Treated wood should not be used where it may come into direct or indirect contact with drinking water, except for uses involving incidental contact such as docks and bridges.

- Logs treated with pentachlorophenol should not be used for log homes. Wood treated with creosote or pentachlorophenol should not be used where it will be in frequent or prolonged contact with bare skin (for example, chairs and other outdoor furniture), unless an effective sealer has been applied. Creosote- and pentachlorophenol-treated wood should not be used in residential, industrial, or commercial interiors except for laminated beams or building components that are in ground contact and are subject to decay or insect infestation and where two coats of an appropriate sealer are applied. Do not use creosote- or pentachlorophenol-treated wood for farrowing or brooding facilities.
- Wood treated with pentachlorophenol or creosote should not be used in the interiors of farm buildings where there may be direct contact with domestic animals or livestock that may crib (bite) or lick the wood. In interiors of farm buildings where domestic animals or livestock are unlikely to crib (bite) or lick the wood, creosote- or pentachlorophenol-treated wood may be used for building components that are in ground contact and are subject to decay or insect infestation and where two coats of an appropriate sealer are applied. Sealers may be applied at the installation site. Urethane, shellac, latex epoxy enamel, and varnish are acceptable sealers for pentachlorophenol-treated wood. Coal-tar pitch and coal-tar pitch emulsion are effective sealers for creosote-treated wood-block flooring. Urethane, epoxy, and shellac are acceptable sealers for all creosote-treated wood.

This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them.

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

Chemical Preservatives

Before a wood preservative can be approved for pressure treatment of structural members, it must be evaluated to ensure that it provides the necessary durability and that it does not greatly reduce the strength properties of the wood. The EPA typically does not evaluate how well a wood preservative protects the wood. Traditionally this evaluation has been conducted through the standardization process of the AWPA. The AWPA Book of Standards lists a series of laboratory and field exposure tests that must be conducted when evaluating new wood preservatives. The durability of test products are compared with those of established durable products and nondurable controls. The results of those tests are then presented to the appropriate AWPA subcommittees for review. AWPA subcommittees are composed of representatives from industry, academia, and government agencies who have familiarity with conducting and interpreting durability evaluations. Preservative standardization by AWPA is a two-step process. If the performance of a new preservative is considered appropriate, it is first listed as a potential preservative. Secondary committee action is needed to have the new preservative listed for specific commodities and to set the required treatment level.

Two General Classes
Wood preservatives have traditionally been divided into two general classes: (1) Oil-type or oil-borne preservatives, such as creosote and petroleum solutions of pentachlorophenol, and (2) waterborne preservatives that are applied as water solutions or with water as the carrier. Many different chemicals are in each of these classes, and each has different effectiveness in various exposure conditions. Some preservatives can be formulated so that they can be delivered with either water or oil-type carriers. In this chapter, both oil-borne and waterborne preservative chemicals are described as to their potential end uses.

Chemical preservatives can be classified into three broad categories: water-borne preservatives, oil-borne preservatives, and light organic solvent preservatives (LOSPs). These are discussed in more detail below.

Timber or lumber that is treated with a preservative generally have it applied through vacuum and/or pressure treatment. The preservatives used to pressure-treat timber are classified as pesticides. Treating timber provides long-term resistance to organisms that cause deterioration. If it is applied correctly, it extends the productive life of timber by five to ten times. If left untreated, wood that is exposed to moisture or soil for sustained periods of time will become weakened by various types of fungi, bacteria or insects.

Waterborne Preservatives

Waterborne preservatives are often used when cleanliness and paintability of the treated wood are required. Formulations intended for use outdoors have shown high resistance to leaching and very good performance in service. Waterborne preservatives are included in specifications for items such as lumber, timber, posts, building foundations, poles, and piling. Because water is added to the wood in the treatment process, some drying and shrinkage will occur after installation unless the wood is kiln-dried after treatment.

Copper is the primary biocide in many wood preservative formulations used in ground contact because of its excellent fungicidal properties and low mammalian toxicity. Because some types of fungi are copper tolerant, preservative formulations often include a co-biocide to provide further protection.

Inorganic arsenicals are a restricted-use pesticide. For use and handling precautions of pressure-treated wood containing inorganic arsenicals, refer to the EPA-approved Consumer Information Sheets. Water is the most common solvent carrier in preservative formulations due to its availability and low cost. Water-borne systems do however have the drawback that they swell timber, leading to increased twisting, splitting and checking than alternatives.

Acid Copper Chromate (ACC)

Acid copper chromate (ACC) contains 31.8% copper oxide and 68.2% chromium trioxide (AWPA P5). The solid, paste, liquid concentrate, or treating solution can be made of copper sulfate, potassium dichromate, or sodium dichromate. Tests on stakes and posts exposed to decay and termite attack indicate that wood well impregnated with ACC generally provides acceptable service. However, some specimens placed in ground contact have shown vulnerability to attack by copper-tolerant fungi. ACC has often been used for treatment of wood in cooling towers. Its current uses are restricted to applications similar to those of chromated copper arsenate (CCA).

ACC and CCA must be used at low treating temperatures (38 to 66 °C (100 to 150 °F)) because they are unstable at higher temperatures. This restriction may involve some difficulty when higher temperatures are needed to obtain good treating results in woods such as Douglas-fir. This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

Ammoniacal Copper Zinc Arsenate (ACZA)
Ammoniacal copper zinc arsenate (ACZA) is commonly used on the West Coast of North America for the treatment of Douglas-fir. The penetration of Douglas-fir heartwood is improved with ACZA because of the chemical composition and stability of treating at elevated temperatures. Wood treated with ACZA performs and has characteristics similar to those of wood treated with CCA.

ACZA should contain approximately 50% copper oxide, 25% zinc oxide, and 25% arsenic pentoxide dissolved in a solution of ammonia in water (AWPA P5). The weight of ammonia is at least 1.38 times the weight of copper oxide. To aid in solution, ammonium bicarbonate is added (at least equal to 0.92 times the weight of copper oxide). ACZA replaced an earlier formulation, ammoniacal copper arsenate (ACA) that was used for many years in the United States and Canada.

Chromated Copper Arsenate (CCA)
(Most of this information will seem to repeat throughout this manual that is because the widespread use of this chemical.) Chromated copper arsenate or CCA, is a chemical preservative that protects wood from rotting due to insects and microbial agents. CCA contains arsenic, chromium and copper. CCA has been used to pressure treat lumber used for decks, playgrounds (playsets) and other outdoor uses since the 1930's. Since the 1970's, the majority of the wood used in residential settings was CCA-treated wood.

CCA is a registered chemical pesticide that is subject to U.S. Environmental Protection Agency's (EPA's) regulation under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The playground equipment made with wood treated with CCA is the jurisdictional responsibility of the CPSC and would be subject to the rules of the CPSC's Federal Hazardous Substances Act if found to be a hazardous substance.

Chromated copper arsenate (CCA) is a wood preservative used for timber treatment since the mid-1930s. It is a mix of copper, chromium, and arsenic formulated as oxides or salts. It preserves the wood from decay fungi, wood attacking insects, including termites, and marine borers. It also improves the weather-resistance of treated timber and may assist paint adherence in the long term.

Tanalith" "SupaTimber" and "Celcure"
CCA is known by many trade names, including the worldwide brands "Tanalith" "SupaTimber" and "Celcure". The chromium acts as a chemical fixing agent and has little or no preserving properties; it helps the other chemicals to fix in the timber, binding them through chemical complexes to the wood's cellulose and lignin. The copper acts primarily to protect the wood against decay fungi and bacteria, while the arsenic is the main insecticidal component of CCA.

CCA is widely used around the world as a heavy duty preservative, often as an alternative to creosote, and pentachlorophenol. Other water-borne preservatives like CCA include alkaline copper quaternary compounds (ACQ), copper azole (CuAz), ammoniacal copper zinc arsenate (ACZA), copper citrate, and copper HDO (CuHDO)

Recognized for the greenish tint it imparts to timber, CCA is a preservative that has been extremely common for many decades. Over time small amounts of the CCA chemicals, mainly the arsenic, may leach out of the treated timber.

This is particularly the case in acidic environments. The chemicals may leach from the wood into surrounding soil, resulting in concentrations higher than naturally occurring background levels. A study found that 12–13 percent of the CCA leached from treated wood buried in compost during a 12-month period.

On the other hand there have been many other studies in less aggressive soil types that show leaching to be as low as 0.5 ppm (red pine poles in service,) or up to 14 ppm (treated pine in garden beds). Soil contamination due to the presence of CCA-treated wood after 45 years is minimal. Should any chemicals leach from the wood they are likely to bind to soil particles, especially in soils with clay or soils that are more alkaline than neutral.

A number of countries have reviewed CCA during recent years and have looked at limiting the public exposure to CCA-treated timber by restricting its application in residential situations. These reviews have resulted from increasing public pressures and perceptions that arsenic-containing timber poses a health hazard. In response to these pressures the preservation industry in the USA and Canada volunteered not to use CCA for the treatment of residential timber, and on 1 January 2004 the United States Environmental Protection Agency (EPA) began restricting the use of CCA for such purposes.

Exceptions were allowed, including the treatment of shakes and shingles, permanent wood foundations, and certain commercial applications. It should be emphasized however that the regulatory agencies advised that CCA-treated timber products already in use pose no significant threat to health. Indeed CCA will continue to be used in North America in a wide variety of commercial and industrial applications such as poles, piling, retaining structures and many others.

CCA timber is still in widespread use in many countries and remains an economical option for conferring durability to perishable timbers such as plantation grown pine. Although widespread restrictions followed the publication of studies which showed low-level leaching from in-situ timbers (such as children's playground equipment) into surrounding soil, a more serious risk is presented if CCA-treated timber is burnt in confined spaces such as a domestic fire or barbecue. Scrap CCA construction timber continues to be widely burnt through ignorance, in both commercial and domestic fires.

Notwithstanding this, disposal by burning i.e. in approved incinerators is an acceptable option. It is particularly attractive if there is some energy captured in the process. In addition, CCA treated timber wastes can also be effectively incinerated using high temperatures, i.e. 800°-1100°C.

Disposal of large quantities of CCA-treated wastes or spent timber at the end of its lifecycle has been traditionally through controlled landfill sites. Such sites are lined to make them impervious in order to prevent losses to the water table and they are covered to prevent rainfall washing out any contained potential toxicants. These controlled sites handle a range of waste materials potentially more noxious than that posed by CCA-treated timber, e.g. paint-stuffs, car batteries, etc. Today, landfill sites are becoming scarcer and disposal of waste materials is becoming economically unattractive. The wood preservation and timber industries are therefore researching better ways of dealing with waste treated timber, including CCA-treated material.

In CCA treatment, copper is the primary fungicide, arsenic is a secondary fungicide and an insecticide, and chromium is a fixative which also provides ultraviolet (UV) light resistance.

Recognized for the greenish tint it imparts to timber, CCA is a preservative that was extremely common for many decades.

Once decay has started in a piece of wood, the rate and extent of deterioration depend on the duration of favorable conditions for fungal growth. Decay will stop when the temperature of the wood is either too low or too high or when the moisture content is lower than the fungi's requirements.

Decay can resume when the temperature and moisture content become favorable again. Early decay is more easily noted on freshly exposed surfaces of unseasoned wood than on wood that has been exposed and discolored by the weather.

Pressure Treatment Process

In the pressure treatment process, an aqueous solution of CCA is applied using a vacuum and pressure cycle, and the treated wood is then stacked to dry. During the process, the mixture of oxides reacts to form insoluble compounds, helping with leaching problems.

The process can apply varying amounts of preservative at varying levels of pressure to protect the wood against increasing levels of attack. Increasing protection can be applied (in increasing order of attack and treatment) for: exposure to the atmosphere, implantation within soil, or insertion into a marine environment.

In the last decade concerns were raised that the chemicals may leach from the wood into surrounding soil, resulting in concentrations higher than naturally occurring background levels. A study cited in Forest Products Journal found 12–13% of the chromated copper arsenate leached from treated wood buried in compost during a 12-month period. Once these chemicals have leached from the wood, they are likely to bind to soil particles, especially in soils with clay or soils that are more alkaline than neutral. In the United States the powerful US Consumer Product Safety Commission issued a report in 2002 stating that exposure to arsenic from direct human contact with CCA treated wood may be higher than was previously thought. On 1 January 2004, the Environmental Protection Agency (EPA) in a voluntary agreement with industry began restricting the use of CCA in treated timber in residential and commercial construction, with the exception of shakes and shingles, permanent wood foundations, and certain commercial applications. This was in an effort to reduce the use of arsenic and improve environmental safety, although the EPA were careful to point out that they had not concluded that CCA treated wood structures in service posed an unacceptable risk to the community. The EPA did not call for the removal or dismantling of existing CCA treated wood structures.

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Alkaline Copper Quaternary

Alkaline copper quaternary (ACQ) is a preservative made of copper, a fungicide, and a quaternary ammonium compound (quat), an insecticide which also augments the fungicidal treatment is a wood preservative that has come into wide use in the USA, Europe, Japan and Australia following restrictions on CCA. Its use is governed by national and international standards, which determine the volume of preservative uptake required for a specific timber end use.

Since it contains high levels of copper, ACQ-treated timber is five times more corrosive to common steel. It is necessary to use double-galvanized or stainless steel fasteners in ACQ timber. Use of fasteners meeting or exceeding requirements for ASTM A 153 Class D meet the added requirements for fastener durability. The U.S. began mandating the use of non-arsenic containing wood preservatives for virtually all residential use timber in 2004.

The American Wood Protection Association (AWPA) standards for ACQ require a retention of 0.15 lb/ft3 (PCF) for above ground use and 0.40 lb/ft^3 for ground contact.

Chemical Specialties, Inc. (CSI, now Viance) received U.S. Environmental Protection Agency's Presidential Green Chemistry Challenge Award in 2002 for commercial introduction of ACQ.
Its widespread use has eliminated major quantities of arsenic and chromium previously contained in CCA.

Alkaline Copper Quat (ACQ)
Alkaline copper quat (ACQ) has an actives composition of 67% copper oxide and 33% quaternary ammonium compound (quat). Multiple variations of ACQ have been standardized. ACQ type B (ACQ–B) is an ammoniacal copper formulation, ACQ type D (ACQ–D) is an amine copper formulation, and ACQ type C (ACQ–C) is a combined ammoniacal-amine formulation with a slightly different quat compound. The multiple formulations of ACQ allow some flexibility in achieving compatibility with a specific wood species and application. When ammonia is used as the carrier, ACQ has improved ability to penetrate difficult-to-treat wood species. However, if the wood species is readily treatable, such as Southern Pine sapwood, an amine carrier can be used to provide a more uniform surface appearance. Recently ACQ has been formulated using small particles of copper rather than copper solubilized in ethanolamine. These formulations are discussed in more detail in the Preservatives with ICC–ES Evaluation Reports section. Use of particulate copper formulations of ACQ is currently limited to permeable woods (such as species of pine with a high proportion of sapwood), but efforts continue to adapt the treatment to a broader range of wood species.

Alkaline Copper DCOI (ACD)
Alkaline copper DCOI (ACD) is a recently proposed formulation of alkaline copper ethanolamine that utilizes 4,5-dichloro-2-N-octyl-4-isothiazolin-3-one (DCOI) as co-biocide to provide protection against copper-tolerant fungi. The ratio of alkaline copper to DCOI in the formulation ranges from 20:1 to 25:1. The ACD formulation is listed as a preservative in AWPA standards. It has been proposed for both above-ground and ground-contact applications, but at the time this chapter was finalized it had not yet been standardized for treatment of any commodities.

Copper bis(dimethyldithiocarbamate) (CDDC)
Copper bis(dimethyldithiocarbamate) (CDDC) is a reaction product formed in wood as a result of the dual treatment of two separate treating solutions. The first treating solution contains a maximum of 5% bivalent copper–ethanolamine (2-aminoethanol), and the second treating solution contains a minimum of 2.5% sodium dimethyldithiocarbamate (AWPA P5). Although this preservative is not currently commercially available, CDDC-treated wood products are included in the AWPA Commodity Standards for uses such as residential construction.

Copper Azole
Copper azole preservative (denoted as CA-B and CA-C under American Wood Protection Association/AWPA standards) is a major copper based wood preservative that has come into wide use in Canada, the USA, Europe, Japan and Australia following restrictions on CCA. Its use is governed by national and international standards, which determine the volume of preservative uptake required for a specific timber end use.

Copper azole is similar to ACQ with the difference being that the dissolved copper preservative is augmented by an azole co-biocide instead of the quat biocide used in ACQ. The azole co-biocide yields a copper azole product that is effective at lower retentions than required for equivalent ACQ performance.

It is marketed widely under the Wolmanized brand in North America and the Tanalith brand across Europe and other international markets.

The AWPA standard retention for CA-B is 0.10 lb./ft^3 for above ground applications and 0.21 lb./ft^3 for ground contact applications. Type C copper azole, denoted as CA-C, has been introduced under the Wolmanized brand. The AWPA standard retention for CA-C is 0.06 lb./ft^3 for above ground applications and 0.15 lb./ft^3 for ground contact applications.

The copper azole preservative incorporates organic triazoles such as tebuconazole or propiconazole as the co-biocide, which are also used to protect food crops. The general appearance of wood treated with copper azole preservative is similar to CCA with a green coloration.

Copper HDO (CXA)
Copper HDO (CXA) is an amine copper water-based preservative that has been used in Europe and was recently standardized in the United States. The active ingredients are copper oxide, boric acid, and copper–HDO (bis-(N-cyclohexyldiazeniumdioxy copper). The appearance and handling characteristics of wood treated with copper HDO are similar to those of the other amine copper-based treatments. It is also referred to as copper xyligen. Currently, copper HDO is standardized only for applications that are not in direct contact with soil or water.

Copper Naphthenate (Waterborne)
Waterborne copper naphthenate (CuN–W) has an actives composition similar to oil-borne copper naphthenate, but the actives are carried in a solution of ethanolamine and water instead of petroleum solvent. Wood treated with the waterborne formulation has a drier surface and less odor than the oil-borne formulation. The waterborne formulation has been standardized for above-ground and some ground-contact applications.

Other Copper Compounds
These include, copper chromate, copper citrate, acid copper chromate, and ammoniacal copper zinc arsenate (ACZA). The CuHDO treatment is an alternative to CCA, ACQ and CA used in Europe and in approval stages for United States and Canada. ACZA is generally used for marine applications.

Micronized Copper Technology
Particulate (micronized or dispersed) copper preservative technology has recently been introduced in the USA and Europe. In these systems, the copper is ground to micro sized particles and suspended in water rather than being dissolved in a chemical reaction as is the case with other copper products such as ACQ and Copper Azole. There are currently two particulate copper systems in production.

One system uses a quat biocide system (known as MCQ) and is a take-off of ACQ. The other uses an azole biocide (known as MCA or CA-C) and is a take-off of copper azole.

Proponents of the particulate copper systems make the case that the particulate copper system perform as well or better than the dissolved copper systems as a wood preservative. None of the particulate copper systems have been submitted to the American Wood Protection Association (AWPA) for evaluation, thus the particulate systems should not be used in applications Petition where AWPA standards are required.

However, all of the particulate copper systems have been tested and approved for building code requirements by the International Code Council (ICC). The particulate copper systems provide a lighter color than dissolved copper systems such as ACQ or copper azole.

Proponents of the micronized copper systems claim that the systems are subject to third party inspection under a quality monitor program. However, the monitoring program is not subject to oversight by the American Lumber Standards Committee (ALSC) as is required for the AWPA standard systems.

Two particulate copper systems, one marketed as MicroPro and the other as Wolmanized using CA-C formulation, have achieved Environmentally Preferable Product (EPP) certification. The EPP certification was issued by Scientific Certifications Systems (SCS), and is based on a comparative life-cycle impact assessments with an industry standard.

The copper particle size used in the "micronized" copper products ranges from 1 to 700 nm with an average under 300 nm. Larger particles (such as actual micron-scale particles) of copper do not adequately penetrate the wood cell walls. It is claimed by the proponents of micronized copper products that the copper nano particles which escape the wood will bond readily with organic matter and become biologically inactive.

These micronized preservatives use nano particles of copper oxide, for which there are alleged safety concerns. An environmental group has recently petitioned EPA to revoke the registration of the micronized copper products citing safety issues.

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Borate Preservatives

Boric acid, oxides and salts (borates) are effective wood preservatives and are supplied under numerous brand names throughout the world. Borate treated wood is of low toxicity to humans, and does not contain copper or other heavy metals. However, unlike most other preservatives, borate compounds do not become fixed in the wood and can readily be leached out. Therefore they should not be used where they will be exposed to rain, water or ground contact. Recent interest in low toxicity timber for residential use, along with new regulations restricting some wood preservation agents, has resulted in a resurgence of the use of borate treated wood for floor beams and internal structural members.

Inorganic Boron (Borax–Boric Acid)

Borate preservatives are readily soluble in water and highly leachable and should be used only above ground where the wood is protected from wetting. When used above ground and protected from wetting, this preservative is very effective against decay, termites, beetles, and carpenter ants. Inorganic boron (SBX) is listed in AWPA standards for protected applications such as framing lumber.

The solid or treating solution for borate preservatives (borates) should be greater than 98% pure, on an anhydrous basis (AWPA P5). Acceptable borate compounds are sodium octaborate, sodium tetraborate, sodium pentaborate, and boric acid. These compounds are derived from the mineral sodium borate, which is the same material used in laundry additives.

Sodium Silicate-based Preservatives

Sodium silicate is produced by fusing sodium with sand or heating both ingredients under pressure. It has been in use since the 19th century. It can be a deterrent against insect attack and possesses minor flame-resistant properties; however, it is easily washed out of wood by moisture, forming a flake-like layer on top of the wood.

One company, Timber Treatment Technology, LLC, has found that infusing timber with a chemical solution containing sodium silicate with a specified energy level applied yields wood that not only does not provide flake or layering on the wood, nor does it wash out as others have done in the past; and it provides processed timber that received a class A fire classification. Their processed wood also paints and stains as new wood does. TTT, LLC, sells these products under the name TimberSIL. Other uses include fixing pigments in paintings and cloth printing, and for preserving eggs.

EL2

EL2 is a waterborne preservative composed of the fungicide 4,5-dichloro-2-N-octyl-4-isothiazolin-3-one (DCOI), the insecticide imidacloprid, and a moisture control stabilizer (MCS). The ratio of actives is 98% DCOI and 2% imidacloprid, but the MCS is also considered to be a necessary component to ensure preservative efficacy. EL2 is currently listed in AWPA standards for above-ground applications only (Table 15–1).

KDS
KDS and KDS Type B (KDS–B) utilize copper and polymeric betaine as the primary active ingredients. The KDS formulation also contains boron, and has an actives composition of 41% copper oxide, 33% polymeric betaine, and 26% boric acid. KDS–B does not contain boron and has an actives composition of 56% copper oxide and 44% polymeric betaine. KDS is listed for treatment of commodities used above ground and for general use in contact with soil or fresh water. It is not listed for soil or fresh water contact in severe exposures. The listing includes treatment of common pine species as well as Douglas-fir and western hemlock. KDS–B is currently in the process of obtaining listings for specific commodities. The appearance of KDS-treated wood is similar to that of wood treated with other alkaline copper formulations (light green–brown). It has some odor initially after treatment, but this odor dissipates as the wood dries.

Oligomeric Alkylphenol Polysulfide (PXTS)
PXTS is a recently developed and somewhat unusual preservative system. It is an oligomer formed by the reaction of cresylic acid and sulfur chlorides in the presence of excess sulfur. PXTS is a solid at room temperature but becomes a liquid when heated to above approximately 58 °C. It can also be dissolved and diluted in some aromatic and organic chlorinated solvents. PXTS is not currently listed for treatment of any commodities and is currently not commercially available.

Propiconazole and Tebuconazole
Propiconazole and tebuconazole are organic triazole biocides that are effective against wood decay fungi but not against insects (AWPA P5, P8). They are soluble in some organic solvents but have low solubility in water and are stable and leach resistant in wood. Propiconazole and tebuconazole are currently components of waterborne preservative treatments used for pressure-treatment of wood in the United States, Europe, and Canada. They are also used as components of formulations used to provide mold and sapstain protection. Propiconazole is also standardized for use with AWPA P9 Type C or Type F organic solvents.

Propiconazole–Tebuconazole–Imidacloprid (PTI)
PTI is a waterborne preservative solution composed of two fungicides (propiconazole and tebuconazole) and the insecticide imidacloprid. It is currently listed in AWPA standards for above-ground applications only. The efficacy of PTI is enhanced by the incorporation of a water-repellent stabilizer in the treatment solutions, and lower retentions are allowed with the stabilizer.

ESR–1721
ESR–1721 recognizes three preservative formulations. Two are the same formulations of copper azole (CA–B and CA–C) also listed in AWPA standards. The other (referred to here as ESR–1721) uses particulate copper that is ground to sub-micron dimensions and dispersed in the treatment solution.

Wood treated with ESR–1721 has a lighter green color than the CA–B or CA–C formulations because the copper is not dissolved in the treatment solution. All three formulations are listed for treatment of commodities used in a range of applications, including contact with soil or freshwater. Use of ESR–1721 (dispersed copper) is currently limited to easily treated pine species.

ESR–1980
ESR–1980 includes a listing for both the AWPA standardized formulation of ACQ–D and a waterborne, micronized copper version of alkaline copper quat (referred to here as ESR–1980). The formulation is similar to ACQ in that the active ingredients are 67% copper oxide and 33% quaternary ammonium compound. However, in ESR–1980 the copper is ground to sub-micron dimensions and suspended in the treatment solution instead of being dissolved in ethanolamine. The treated wood has little green color because the copper is not dissolved in the treatment solution. The use of the particulate form of copper is currently limited to the more easily penetrated pine species, but efforts are underway to adapt the formulation for treatment of a broader range of wood species. ESR–1980 is listed for treatment of commodities used in both above-ground and ground-contact applications.

ESR–2067
ESR–2067 is an organic waterborne preservative with an actives composition of 98% tebuconazole (fungicide) and 2% imidacloprid (insecticide). The treatment does not impart any color to the wood. It is currently listed only for treatment of commodities that are not in direct contact with soil or standing water.

ESR–2240
ESR–2240 is a waterborne formulation that utilizes finely ground (micronized) copper in combination with tebuconazole in an actives ratio of 25:1. It is listed for above-ground and ground-contact applications. In addition to wood products cut from pine species, ESR–2240 can be used for treatment of hem–fir lumber and Douglas-fir plywood.

ESR–2325
ESR–2325 is another waterborne preservative that utilizes finely ground copper particles and tebuconazole as actives. The ratio of copper to tebuconazole in the treatment solution is 25:1. Its use is currently limited to more readily treated species such as the Southern Pine species group, but Douglas-fir plywood is also listed. ESR–2315 is listed for treatment of wood used above-ground and in contact with soil or fresh water.

ESR–2711
ESR–2711 combines copper solubilized in ethanolamine with the fungicide 4,5-dichloro-2-N-octyl-4-isothiazolin-3-one (DCOI). The ratio of copper (as CuO) to DCOIT ranges from 10:1 to 25:1. The ESR listing provides for both above-ground and ground-contact applications. The appearance of the treated wood is similar to that of wood treated with other formulations utilizing soluble copper, such as ACQ. It is currently only listed for treatment of pine species.

2017 Changes to EPA's Farm Worker Protection Standard
In late 2015 the Environmental Protection Agency issued the long awaited revision to the Worker Protection Standard (WPS). 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 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.

Oil-Borne or Oil-Type Preservatives Sub-Section

Oil-type wood preservatives are some of the oldest preservatives, and their use continues in many applications. Wood does not swell from treatment with preservative oils, but it may shrink if it loses moisture during the treating process. Creosote and solutions with heavy, less volatile petroleum oils often help protect wood from weathering but may adversely influence its cleanliness, odor, color, paintability, and fire performance. Volatile oils or solvents with oil-borne preservatives, if removed after treatment, leave the wood cleaner than do the heavy oils but may not provide as much protection. Wood treated with some preservative oils can be glued satisfactorily, although special processing or cleaning may be required to remove surplus oils from surfaces before spreading the adhesive.

Coal-Tar Creosote and Creosote Solutions
Coal-tar creosote (creosote) is a black or brownish oil made by distilling coal tar that is obtained after high-temperature carbonization of coal. Advantages of creosote are (a) high toxicity to wood-destroying organisms; (b) relative insolubility in water and low volatility, which impart to it a great degree of permanence under the most varied use conditions; (c) ease of application; (d) ease with which its depth of penetration can be determined; (e) relative low cost (when purchased in wholesale quantities); and (f) lengthy record of satisfactory use. Creosote is commonly used for heavy timbers, poles, piles, and railroad ties.

AWPA Standard P1/P13 provides specifications for coal-tar creosote used for preservative treatment of piles, poles, and timber for marine, land, and freshwater use. The character of the tar used, the method of distillation, and the temperature range in which the creosote fraction is collected all influence the composition of the creosote, and the composition may vary within the requirements of standard specifications. Under normal conditions, requirements of these standards can be met without difficulty by most creosote producers.

Coal tar or petroleum oil may also be mixed with coal-tar creosote, in various proportions, to lower preservative costs. AWPA Standard P2 provides specifications for coal-tar solutions. AWPA Standard P3 stipulates that creosote–petroleum oil solution shall consist solely of specified proportions of 50% coal-tar creosote by volume (which meets AWPA standard P1/P13) and 50% petroleum oil by volume (which meets AWPA standard P4). However, because no analytical standards exist to verify the compliance of P3 solutions after they have been mixed, the consumer assumes the risk of using these solutions. These creosote solutions have a satisfactory record of performance, particularly for railroad ties and posts where surface appearance of the treated wood is of minor importance.

Compared with straight creosote, creosote solutions tend to reduce weathering and checking of the treated wood. These solutions have a greater tendency to accumulate on the surface of the treated wood (bleed) and penetrate the wood with greater difficulty because they are generally more viscous than is straight creosote. High temperatures and pressures during treatment, when they can be safely used, will often improve penetration of high-viscosity solutions.

Although coal-tar creosote or creosote solutions are well suited for general outdoor service in structural timbers, creosote has properties that are undesirable for some purposes.

The color of creosote and the fact that creosote-treated wood usually cannot be painted satisfactorily make this preservative unsuitable where appearance and paintability are important.

The odor of creosote-treated wood is unpleasant to some people. Also, creosote vapors are harmful to growing plants, and foodstuffs that are sensitive to odors should not be stored where creosote odors are present. Workers sometimes object to creosote-treated wood because it soils their clothes, and creosote vapor photosensitizes exposed skin.

With precautions to avoid direct skin contact with creosote, there appears to be minimal danger to the health of workers handling or working near the treated wood. The EPA or the wood treater should be contacted for specific information on this subject.

In 1986, creosote became a restricted-use pesticide, and its use is currently restricted to pressure-treatment facilities. For use and handling of creosote-treated wood, refer to the EPA-approved Consumer Information Sheet.

Freshly creosoted timber can be ignited and burns readily, producing a dense smoke. However, after the timber has seasoned for some months, the more volatile parts of the oil disappear from near the surface and the creosoted wood usually is little, if any, easier to ignite than untreated wood. Until this volatile oil has evaporated, ordinary precautions should be taken to prevent fires. Creosote adds fuel value, but it does not sustain ignition.

Other Creosotes

Creosotes distilled from tars other than coal tar have been used to some extent for wood preservation, although they are not included in current AWPA specifications. These include wood-tar creosote, oil-tar creosote, and water–gas-tar creosote. These creosotes provide some protection from decay and insect attack but are generally less effective than coal-tar creosote.

Pentachlorophenol Solutions

Water-repellent solutions containing chlorinated phenols, principally pentachlorophenol (penta), in solvents of the mineral spirits type, were first used in commercial dip treatments of wood by the millwork industry in about 1931. Commercial pressure treatment with pentachlorophenol in heavy petroleum oils on poles started in about 1941, and considerable quantities of various products soon were pressure treated. AWPA Standard P8 defines the properties of pentachlorophenol preservative, stating that pentachlorophenol solutions for wood preservation shall contain not less than 95% chlorinated phenols, as determined by titration of hydroxyl and calculated as pentachlorophenol.

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AWPA standard P9 defines solvents and formulations for organic preservative systems. The performance of pentachlorophenol and the properties of the treated wood are influenced by the properties of the solvent used. A commercial process using pentachlorophenol dissolved in liquid petroleum gas (LPG) was introduced in 1961, but later research showed that field performance of penta–LPG systems was inferior to penta–P9 systems. Thus, penta–LPG systems are no longer used. The heavy petroleum solvent included in AWPA P9 Type A is preferable for maximum protection, particularly when wood treated with pentachlorophenol is used in contact with the ground. The heavy oils remain in the wood for a long time and do not usually provide a clean or paintable surface.

Because of the toxicity of pentachlorophenol, care is necessary when handling and using it to avoid excessive personal contact with the solution or vapor. Do not use indoors or where human, plant, or animal contact is likely. Pentachlorophenol became a restricted-use pesticide in November 1986 and is currently only available for use in pressure treatment. For use and handling precautions, refer to the EPA-approved Consumer Information Sheet. The results of pole service and field tests on wood treated with 5% pentachlorophenol in a heavy petroleum oil are similar to those with coal-tar creosote. This similarity has been recognized in the preservative retention requirements of treatment specifications.

Pentachlorophenol is effective against many organisms, such as decay fungi, molds, stains, and insects. Because pentachlorophenol is ineffective against marine borers, it is not recommended for the treatment of marine piles or timbers used in coastal waters.

Copper Naphthenate

Copper naphthenate is an organometalic compound formed as a reaction product of copper salts and naphthenic acids that are usually obtained as byproducts in petroleum refining. It is a dark green liquid and imparts this color to the wood. Weathering turns the color of the treated wood to light brown after several months of exposure. The wood may vary from light brown to chocolate brown if heat is used in the treating process. AWPA P8 standard defines the properties of copper naphthenate, and AWPA P9 covers the solvents and formulations for organic preservative systems.

Copper naphthenate is effective against wood-destroying fungi and insects. It has been used commercially since the 1940s and is currently standardized for a broad range of applications. Copper naphthenate is not a restricted-use pesticide but should be handled as an industrial pesticide. It may be used for superficial treatment, such as by brushing with solutions with a copper content of 1% to 2% (approximately 10% to 20% copper naphthenate). Water-based formulations of copper naphthenate may also be available.

Oxine Copper (copper-8-quinolinolate)

Oxine copper (copper-8-quinolinolate) is an organometallic compound, and the formulation consists of at least 10% copper-8-quinolinolate, 10% nickel-2-ethylhexanoate, and 80% inert ingredients (AWPA P8). It is accepted as a stand-alone preservative for aboveground use for sapstain and mold control and is also used for pressure treating. A water-soluble form can be made with dodecylbenzene sulfonic acid, but the solution is corrosive to metals.

Oxine copper solutions are greenish brown, odorless, toxic to both wood decay fungi and insects, and have a low toxicity to humans and animals. Because of its low toxicity to humans and animals, oxine copper is the only EPA-registered preservative permitted by the U.S. Food and Drug Administration for treatment of wood used in direct contact with food. Some examples of its uses in wood are commercial refrigeration units, fruit and vegetable baskets and boxes, and water tanks. Oxine copper solutions have also been used on non-wood materials, such as webbing, cordage, cloth, leather, and plastics.

Zinc Naphthenate
Zinc naphthenate is similar to copper naphthenate but is less effective in preventing decay from wood-destroying fungi and mildew. It is light colored and does not impart the characteristic greenish color of copper naphthenate, but it does impart an odor. Waterborne and solvent-borne formulations are available. Zinc naphthenate is not widely used for pressure treating.

3-Iodo-2-Propynyl Butyl Carbamate
3-Iodo-2-propynyl butyl carbamate (IPBC) is a fungicide that is used as a component of sapstain and millwork preservatives. It is also included as a fungicide in several surface-applied water-repellent-preservative formulations. Waterborne and solvent-borne formulations are available. Some formulations yield an odorless, treated product that can be painted if dried after treatment. It is listed as a pressure-treatment preservative in the AWPA standards but is not currently standardized for pressure treatment of any wood products. IPBC also may be combined with other fungicides, such as didecyldimethylammonium chloride in formulations used to prevent mold and sapstain.

IPBC/Permethrin
IPBC is not an effective insecticide and has recently been standardized for use in combination with the insecticide permethrin (3-phenoxybenzyl-(1R,S)-cis, trans-2, 2-dimethyl-3-(2,2-dichlorovinyl) cycloproanecarboxylate) under the designation IPBC/PER. Permethrin is a synthetic pyrethroid widely used for insect control in agricultural and structural applications.

The ratio of IPBC to permethrin in the IPBC/PER varies between 1.5:1 and 2.5:1. The formulation is carried in a light solvent such as mineral spirits, making it compatible with composite wood products that might be negatively affected by the swelling associated with water-based pressure treatments. The IPBC/PER formulation is intended only for use in above-ground applications. The formulation is listed as a preservative in AWPA standards, but at the time this chapter was finalized it had not yet been standardized for treatment of any commodities.

Alkyl Ammonium Compounds
Alkyl ammonium compounds such as didecyldimethylammonium chloride (DDAC) or didecyldimethylammonium carbonate (DDAC)/bicarbonate (DDABC) have some efficacy against both wood decay fungi and insects. They are soluble in both organic solvents and water and are stable in wood as a result of chemical fixation reactions. DDAC and DDABC are currently being used as a component of alkaline copper quat (ACQ) (see section on Waterborne Preservatives) for above-ground and ground-contact applications and as a component of formulations used for sapstain and mold control.

4,5-Dichloro-2-N-Octyl-4-Isothiazolin-3-One (DCOI)
4,5-dichloro-2-N-octyl-4-isothiazolin-3-one (DCOI) is a biocide that is primarily effective against wood decay fungi. It is soluble in organic solvents but not in water, and it is stable and leach resistant in wood. The solvent used in the formulation of the preservative is specified in AWPA P9 Type C. DCOI can be formulated to be carried in a waterborne system, and it is currently used as a component in the waterborne preservative EL2. It has also recently been proposed for use as co-biocide in a copper ethanolamine formulation referred to as ACD.

Chlorpyrifos
Chlorpyrifos (CPF) is an organophosphate insecticide that has been widely used for agricultural purposes. It has been standardized by the AWPA as a preservative but is not currently used as a component of commercial pressure treatments. Chloropyrifos is not effective in preventing fungal attack and should be combined with an appropriate fungicidal preservative for most applications.

Treatments for Wood Composites
Many structural composite wood products, such as glued-laminated beams, plywood, and parallel strand and laminated veneer lumber, can be pressure-treated with wood preservatives in a manner similar to lumber. However, flake- or fiber-based composites are often protected by adding preservative during manufacture.

A commonly used preservative for these types of composites is zinc borate. Zinc borate is a white, odorless powder with low water solubility that is added directly to the furniture or wax during panel manufacture. Zinc borate has greater leach resistance than the more soluble forms of borate used for pressure treatment and thus can be used to treat composite siding products that are exposed outdoors but partially protected from the weather.

Zinc borate is currently listed in AWPA Commodity Standard J for non-pressure treatment of laminated strand lumber, oriented strandboard, and engineered wood siding. The standard requires that these products have an exterior coating or laminate when used as siding. Another preservative that has been used to protect composites is ammoniacal copper acetate, which is applied by spraying the preservative onto the OSB flakes before drying.

Fire Retardant Treated
This treated wood utilizes a fire retardant chemical that remains stable in high temperature environments. The fire retardant is applied under pressure at a wood treating plant like the preservatives described above, or applied as a surface coating.

In both cases, treatment provides a physical barrier to flame spread. The treated wood chars but does not oxidize. Effectively this creates a convective layer that transfers flame heat to the wood in a uniform way which significantly slows the progress of fire to the material. There are several commercially available wood-based construction materials using pressure-treatment (such as those marketed in the United States and elsewhere under the trade names of 'Dricon', 'D-Blaze,' and 'Pyro-Guard', as well as factory-applied coatings under the trade names of 'PinkWood' and 'BluWood'. Some site-applied coatings as well as brominated fire retardants have lost favor due to safety concerns as well as concerns surrounding the consistency of application. Specialized treatments also exist for wood used in weather-exposed applications.

Toxic Oil-borne Preservatives
These include pentachlorophenol and creosote. They are toxic, have an unpleasant odor and are generally not used in consumer products.

Coal-tar Creosote
Creosote is a tar-based preservative that has been commonly used for telephone poles and railroad ties. Creosote is one of the oldest wood preservatives, and was originally derived from a wood distillate. These days virtually all creosote is manufactured from the distillation of coal tar. It often collects inside chimneys and may cause a fire hazard. Creosote is regulated as a pesticide and is not usually sold to the general public. It is still used for railroad ties (also called railway sleepers and cross ties) and utility poles.

Linseed Oil
Linseed oil is used to preserve Wood fences, log cabins, and wood furniture. (Such woods as Willow, Pine, oak and exc.) The function of linseed oil as a preservative is believed to be related to its action as a water repellent and drying agent rather than a direct biocidal activity.

A number of companies have developed natural-oil-only-based treatments; no synthetic preservative such as permethrin is added. Menz Holz OHT use autoclave impregnation with linseed, sunflower and rapeseed oil for 6 to 8 hours.

Naphthenic Acid
Naphthenic acid is the name for an unspecific mixture of several cyclopentyl and cyclohexyl carboxylic acids with molecular weight of 120 to well over 700 atomic mass units. The main fraction are carboxylic acids with a carbon backbone of 9 to 20 carbons. The naphtha fraction of the crude oil refining is oxidized and yields naphthenic acid. The composition differs with the crude oil composition and the conditions during refining and oxidation. Naphthenic acids are present in crude oil and leads to corrosion problems within the oil refineries; therefore "naphthenic acid corrosion" phenomena are well researched. Crude oils with a high content of naphthenic acids are often referred to as high TAN (Total Acid Number) crude oils or high acid crude oil (HAC). There is also a conference called the High TAN Crude Conference which was first organized in 2005.

Mixtures of a flammable substance and naphthenic and palmitic acid aluminum salts were discovered during World War II to make napalm. These acids caused flammable hydrocarbons to gel. Other uses of naphthenic acids depend on the refinement of the material. Naphthenic acid is used in corrosion inhibitors, wood preservatives, lubricant and fuel additives, driers for paints and inks, and in the production of metal soaps.

Naphthenates
Naphthenates are the salts of naphthenic acids. These salts have industrial applications including synthetic detergents, lubricants, corrosion inhibitors, fuel and lubricating oil additives, wood preservations, insecticides, fungicides, acaricides, wetting agents, and oil drying agents used in painting and wood surface treatment. Industrially useful naphthenates include barium naphthenate, calcium naphthenate, cobalt naphthenate, copper naphthenate, lead naphthenate, magnesium naphthenate, manganese naphthenate, nickel naphthenate, sodium naphthenate, vanadyl naphthenate and zinc naphthenate.

Other Emulsions

Light Organic Solvent Preservatives (LOSP)

This class of timber treatments use white spirit, or light oils such as kerosene, as the solvent carrier to deliver preservative compounds into timber. Synthetic pyrethroids are typically used as an insecticide, such as permethrin, bifenthrin or deltamethrin. The most common formulations use Permethrin as an insecticide, and Propaconazole and Tebuconazole as fungicides. While still using a chemical preservative, this formulation contains no heavy-metal compounds.

With the introduction of strict volatile organic compound (VOC) laws in the European Union, LOSPs have disadvantages due to the high cost and long process times associated with vapor-recovery systems. LOSPs have been emulsified into water-based solvents. While this does significantly reduce VOC emissions, the timber swells during treatment, removing many of the advantages of LOSP formulations.

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New Technologies

Glass Fortified Wood

Glass Fortified Wood (glass wood) is lumber that has gone through a process that intermixes a non-toxic sodium silicate (water glass) based formula throughout the wood fibers protecting the wood from fire, rot and insect damage. With glass encapsulating the wood fibers, the lumber becomes harder and the strength is increased. Glass wood can be used for in ground contact applications, in water applications and it is Class-A fire retardant.

Wood Acetylation

Chemical modification of wood at the molecular level has been used to improve its performance properties. Many chemical reaction systems for the modification of wood, especially those using various types of anhydrides, have been published; however, the reaction of wood with acetic anhydride has been the most studied.

The physical properties of any material are determined by its chemical structure. Wood contains an abundance of chemical groups called free hydroxyls. Free hydroxyl groups readily absorb and release water according to changes in the climatic conditions to which they are exposed. This is the main reason why wood's dimensional stability is impacted by swelling and shrinking. It is also believed that the digestion of wood by enzymes initiates at the free hydroxyl sites - which is one of the principal reasons why wood is prone to decay.

Acetylation effectively changes the free hydroxyls within wood into acetyl groups. This is done by reacting the wood with acetic anhydride, which comes from acetic acid (the main component of vinegar). When free hydroxyl groups are transformed to acetyl groups, the ability of the wood to absorb water is greatly reduced, rendering the wood more dimensionally stable and, because it is no longer digestible, extremely durable. In general, softwoods naturally have an acetyl content between 0.5 to 1.5% and more durable hardwoods between 2 to 4.5%. Acetylation takes wood well beyond these levels with corresponding benefits. These include an extended coatings life due to acetylated wood acting as a more stable substrate for paints and translucent coatings. Acetylated wood is non-toxic and does not have the environmental issues associated with traditional preservation techniques.

The acetylation of wood was first done in Germany in 1928 by Fuchs. In 1946, Tarkow, Stamm and Erickson first described the use of wood acetylation to stabilize wood from swelling in water. Since the 1940s, many laboratories around the world have looked at acetylation of many different types of woods and agricultural resources.

In spite of the vast amount of research on chemical modification of wood, and, more specifically, on the acetylation of wood, commercialization did not come easily. The first patent on the acetylation of wood was filed by Suida in Austria in 1930. Later, in 1947, Stamm and Tarkow filed a patent on the acetylation of wood and boards using pyridine as a catalyst. In 1961, the Koppers Company published a technical bulletin on the acetylation of wood using no catalysis but with an organic co-solvent. In 1977, in Russia, Otlesnov and Nikitina came close to commercialization but the process was discontinued presumably because cost-effectiveness could not be achieved. In 2007 a London-based company, with production facilities in The Netherlands, achieved cost-effective commercialization and began large-scale production of acetylated wood.

Although many decay fungi may grow for long periods without producing any external evidence of their presence, others produce "fruiting bodies" on the surface of decaying wood. Fruiting bodies are usually "crusts" or shelf-like "brackets" which are a few inches or so in diameter.

Stain Fungi
Also, surface molds, "mildews," and stain fungi are often found growing on the surface of damp wood and can be confused with decay fungi. Although these organisms may discolor the wood, they do not break down wood fibers and thus do not weaken its structure. However, these organisms indicate that moisture is present and that decay will likely proceed if a wood-rotting fungus becomes established in the wood.

2017 Changes to EPA's Farm Worker Protection Standard

In late 2015 the Environmental Protection Agency issued the long awaited revision to the Worker Protection Standard (WPS). 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 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.

Natural Wood Preservatives Sub-Section

Naturally Rot-Resistant Woods
These species are resistant to decay in their natural state, due to high levels of organic chemicals called extractives, mainly polyphenols. Extractives are chemicals that are deposited in the heartwood of certain tree species as they convert sapwood to heartwood.

Eastern red cedar (Juniperus virginiana) and black locust (Robinia pseudoacacia) have long been used for rot-resistant fence posts and rails in eastern United States, with the black locust also planted in modern times in Europe. Coast redwood is commonly used for similar applications in the western United States.

It should be noted that the natural durability or rot and insect resistance of wood species is always based on the heartwood (or truewood). The sapwood of all timber species should be considered to be non-durable without preservative treatment.

Tung Oil
Tung oil has been known about for hundreds of years in China, where it was used as a preservative for wood ships. The oil penetrates the wood, and then hardens to form an impermeable hydrophobic layer up to 5 mm into the wood. As a preservative it is effective for exterior work above and below ground, but the thin layer makes it less useful in practice. It is not available as a pressure treatment. Some manufacturers recommend tung oil as a stabilizer for CCA.

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Heat Treatments
There is ongoing research as to whether heat treatments can be used to make timber more durable. By heating timber to a certain temperature, it may be possible to make the wood-fiber less appetizing to insects. Although unlikely to be as effective as chemical preservatives, anecdotal evidence suggests some consumers would prefer chemical-free timber preservation methods.

Heat treatment can also improve the properties of the wood with respect to water: lower equilibrium moisture, less moisture deformation, and weather resistance. It is weather-resistant enough to be used, unprotected, in facades or in kitchen tables, where wetting is expected. These processes autoclave the treated wood, subjecting it to pressure and heat, along with nitrogen or water vapor to control drying in a staged treatment process ranging from 24 to 48 hours at temperatures of 180 to 230 °C depending on timber species.

These processes increase the durability, dimensional stability and hardness of the treated wood by at least one class; however, the treated wood is darkened in color, and there are changes in certain mechanical characteristics: specifically, the modulus of elasticity is increased to 10%, and the modulus of rupture is diminished by 5% to 20%; thus, the treated wood requires drilling for nailing to avoid splitting the wood. Certain of these processes cause less of an impact than others in their mechanical effects upon the treated wood. Wood treated with this process is often used for cladding or siding, flooring, furniture and windows.

Mud Treatment

Wood and bamboo can be buried in mud to help protect it from insects and decay. This practice is used widely in Vietnam to build farm houses consisting of a wooden structural frame, a bamboo roof frame and bamboo with mud mixed with rice hay for the walls. While wood in contact with soil will generally decompose more quickly than wood not in contact with soil, it is possible that the predominantly clay soils prevalent in Vietnam provide a degree of mechanical protection against insect attack which compensates for the accelerated rate of decay.

Also, since wood is only subject to bacterial decay under specific temperature and moisture content ranges, submerging it in water-saturated mud can retard decay by saturating the wood's internal cells beyond their moisture decay range.

Application Processes
Introduction and History

Probably the first attempts made to protect wood from decay and insect attack consisted of brushing or rubbing preservatives onto the surfaces of the treated wood. Through trial and error the most effective preservatives and application processes where slowly determined. In the Industrial Revolution, demands for such things as telegraph poles and railroad ties helped to fuel an explosion of new techniques that emerged in the early 19th century. The sharpest rise in inventions took place between 1830 and 1840, when Bethell, Boucherie, Burnett and Kyan were making wood-preserving history. Since then, numerous processes have been introduced or existing processes improved. The goal of modern day wood preservation is to ensure a deep, uniform penetration with reasonable cost, without endangering the environment. The most widespread application processes today are those using artificial pressure through which many woods are being effectively treated, but several species (such as spruce, Douglas-fir, larch, hemlock and fir) are very resistant to impregnation. With the use of incising, the treatment of these woods has been somewhat successful but with a higher cost and not always satisfactory results. One can divide the wood-preserving methods roughly into either non-pressure processes or pressure processes.

Full-cell process

In the full-cell process, the intent is to keep as much of the liquid absorbed into the wood during the pressure period as possible, thus leaving the maximum concentration of preservatives in the treated area. Usually, water solutions of preservative salts are employed with this process but it is also possible to impregnate wood with oil. The desired retention is achieved by changing the strength of the solution. William Burnett patented this development in 1838 of full-cell impregnation with water solutions. The patent covered the use of zinc chloride on water basis, also known as Burnettizing. A full-cell process with oils was patented in 1838 by John Bethell. His patent described the injection of tar and oils into wood by applying pressure in closed cylinders. This process is still used today with some improvements.

Fluctuation Pressure Process
Contrary to the static full-cell and empty-cell processes, the fluctuation process is a dynamic process. By this process the pressure inside the impregnation cylinder changes between pressure and vacuum within a few seconds. There have been inconsistent claims that through this process it is possible to reverse the pit closure by spruce. However, the best results that have been achieved with this process by spruce do not exceed a penetration deeper than 10 mm (0.39 in). Specialized equipment is necessary and therefore higher investment costs are incurred.

Boucherie Process
Developed by Dr. Boucherie of France in 1838, this approach consisted of attaching a bag or container of preservative solution to a standing or a freshly cut tree with bark, branches, and leaves still attached, thereby injecting the liquid into the sap stream. Through transpiration of moisture from the leaves the preservative is drawn upward through the sapwood of the tree trunk.

The modified Boucherie process consists of placing freshly cut, unpeeled timbers onto declining skids, with the stump slightly elevated, then fastening watertight covering caps or boring a number of holes into the ends, and inserting a solution of copper sulfate or other water- borne preservative into the caps or holes from an elevated container. Preservative oils tend to not penetrate satisfactorily by this method. The hydrostatic pressure of the liquid forces the preservative lengthwise into and through the sapwood, thus pushing the sap out of the other end of the timber. After a few days, the sapwood is completely impregnated; unfortunately little or no penetration takes place in the heartwood. Only green wood can be treated in this manner. This process has found considerable usage to impregnate poles and also larger trees in Europe and North America, and has experienced a revival of usage to impregnate bamboo in countries such as Costa Rica, Bangladesh, India and the state of Hawaii.

High Pressure Sap Displacement System
Developed in the Philippines, this method (abbreviated HPSD) consists of a cylinder pressure cap made from a 3 mm thick mild steel plate secured with 8 sets of bolts, a 2-HP diesel engine, and a pressure regulator with 1.4–14 kg/m^2 capacity. The cap is placed over the stump of a pole, tree or bamboo and the preservative is forced into the wood with pressure from the engine.

Incising
First tested and patented by Kolossvary, Haltenberger, and Berdenich of Austria in 1911 and 1912 (U.S. pats. 1,012,207 and 1,018,624) with several improvements from O. P. M. Goss, D. W. Edwards and J. H. Mansfield among others, this process consists of making shallow, slit-like holes in the surfaces of material to be treated, so that deeper and more uniform penetration of preventative may be obtained. The term incising or perforating comes from the Latin incidere, a compound of in and caedere (to cut). Incisions made in sawed material usually are parallel with the grain of the wood.

This process is common in North America (since the 1950s), where Douglas-fir products and pole butts of various species are prepared before treatment. It is most useful for woods that are resistant to side penetration but allow preservative transport along the grain. In the region in which it is produced, it is common practice to incise all sawed Douglas-fir 3 in (76 mm) or more in thickness before treatment.

Unfortunately the impregnation of spruce, the most important structural timber large areas in Europe has shown that unsatisfactory treatment depths have been achieved with impregnation. The maximum penetration of 2 mm (0.079 in) is not sufficient to protect wood in weathered positions. The present-day incising machines consist essentially of four revolving drums fitted with teeth or needles or with lasers that burn the incisions into the wood. Preservatives can be spread along the grain up to 20 mm (0.79 in) in radial and up to 2 mm (0.079 in) in tangential and radial direction.

Cutting and Framing
All cutting and boring of holes should be done prior to preservative treatment. Cutting into the wood in any way after treatment will frequently expose the untreated interior of the timber and permit ready access to decay fungi or insects.

In some cases, wood structures can be designed so that all cutting and framing is done before treatment. Railroad companies have followed this practice and have found it not only practical but economical. Many wood-preserving plants are equipped to carry on such operations as the adzing and boring of crossties; gaining, roofing, and boring of poles; and framing of material for bridges and specialized structures, such as water tanks and barges.

Treatment of the wood with preservative oils results in little or no dimensional change. With waterborne preservatives, however, some change in the size and shape of the wood may occur even though the wood is re-dried to the moisture content it had before treatment. If precision fitting is necessary, the wood is cut and framed before treatment to its approximate final dimensions to allow for slight surfacing, trimming, and reaming of bolt holes. Grooves and bolt holes for timber connectors are cut before treatment and can be reamed out if necessary after treatment.

Non-Pressure Processes
There are numerous non-pressure processes of treating wood which vary primarily in their procedure. The most common of these treatments involve the application of the preservative by means of brushing or spraying, dipping, soaking, steeping or by means of hot and cold bath. There is also a variety of additional methods involving charring, applying preservatives in bored holes, diffusion processes and sap displacement.

Brush and Spray Treatments
Brushing preservatives is a long-practiced method and often used in today's carpentry workshops. Through technology developments it is also possible to spray preservative over the surface of the timber. Some of the liquid is drawn into the wood as the result of capillary action, but this penetration is insignificant and not suitable for long-term weathering. By using the spray method, coal-tar creosote, oil-borne solutions and water-borne salts (to some extent) can also be applied. A thorough brush or spray treatment with coal-tar creosote can add 1 to 3 years to the lifespan of poles or posts. Two or more coats provide better protection than one, but the successive coats should not be applied until the prior coat has dried or soaked into the wood. The wood should be seasoned before treatment.

Dipping
Dipping consists of simply immersing the wood in a bath of creosote or other preservative for a few seconds or minutes. Similar penetrations to that of brushing and spraying processes are achieved. It has the advantage of minimizing hand labor. It requires more equipment and larger quantities of preservative and is not adequate for treating small lots of timber. Usually the dipping process is useful in the treatment of window sashes and doors. Treatment with copper salt preservatives is no longer allowed with this method.

Steeping
In this process the wood is submerged in a tank of water-preservative mix, and allowed to soak for a longer period of time (several days to weeks). This process was developed in the 19th century by John Kyan. The depth and retention achieved depends on factors such as species, wood moisture, preservative and soak duration. The majority of the absorption takes place during the first two or three days, but will continue at a slower pace for an indefinite period. As a result, the longer the wood can be left in the solution, the better treatment it will receive. When treating seasoned timber, both the water and the preservative salt soak into the wood, making it necessary to season the wood a second time. Posts and poles can be treated directly on endangered areas, but should be treated at least 30 cm (0.98 ft) above the future ground level.

The depth obtained during regular steeping periods varies from 5 to 10 mm (0.20 to 0.39 in) up to 30 mm (1.2 in) by sap pine. Due to the low absorption, solution strength should be somewhat stronger than that in pressure processes, around 5% for seasoned timber and 10% for green timber (because the concentration slowly decreases as the chemicals diffuse into the wood). The solution strength should be controlled continually and, if necessary, be corrected with the salt additive. After the timber is removed from the treatment tank, the chemical will continue to spread within the wood if it has sufficient moisture content. The wood should be weighed down and piled so that the solution can reach all surfaces. (Sawed materials stickers should be placed between every board layer.)

Kyanizing
Named after John Howard Kyan, who patented this process in England in 1832, Kyanizing consists of steeping wood in a 0.67% mercuric chloride preservative solution.

Gedrian's Bath
Patented by C. A. Seeley, this process achieves treatment by immersing seasoned wood in successive baths of hot and cold preservatives. During the hot baths, the air expands in the timbers. When the timbers are changed to the cold bath (the preservative can also be changed) a partial vacuum is created within the lumen of the cells, causing the preservative to be drawn into the wood. Some penetration occurs during the hot baths, but most of it takes place during the cold baths. This cycle is repeated with a significant time reduction compared to other steeping processes. Each bath may last 4 to 8 hours or in some cases longer. The temperature of the preservative in the hot bath should be between 60 to 110 °C (140 to 230 °F) and 30 to 40 °C (86 to 104 °F) in the cold bath (depending on preservative and tree species). The average penetration depths achieved with this process ranges from 30 to 50 mm (1.2 to 2.0 in). Both preservative oils and water-soluble salts can be used with this treatment. Due to the longer treatment periods, this method finds little use in the commercial wood preservation industry today.

Pressure Treated Wood

Pressure Processes
Pressure processes are the most permanent method around today in preserving timber life. Pressure processes are those in which the treatment is carried out in closed cylinders with applied pressure and/or vacuum. These processes have a number of advantages over the non-pressure methods. In most cases, a deeper and more uniform penetration and a higher absorption of preservative is achieved. Another advantage is that the treating conditions can be controlled so that retention and penetration can be varied. These pressure processes can be adapted to large-scale production. The high initial costs for equipment and the energy costs are the biggest disadvantages. These treatment methods are used to protect ties, poles and structural timbers and find use throughout the world today. The various pressure processes that are used today differ in details, but the general method is in all cases the same. The treatment is carried out in cylinders. The timbers are loaded onto special tram cars, so called buggies or bogies, and into the cylinder.

These cylinders are then set under pressure often with the addition of higher temperature. As final treatment, a vacuum is frequently used to extract excess preservatives. These cycles can be repeated to achieve better penetration. LOSP treatments often use a vacuum impregnation process. This is possible because of the lower viscosity of the white-spirit carrier used.

In commercial practice, wood is most often treated by immersing it in a preservative in a high-pressure apparatus and applying pressure to drive the preservative into the wood. Pressure processes differ in details, but the general principle is the same. The wood, on cars or trams, is run into a long steel cylinder, which is then closed and filled with preservative. Pressure forces the preservative into the wood until the desired amount has been absorbed.

Considerable preservative is absorbed, with relatively deep penetration. Three pressure processes are commonly used: full cell, modified full cell, and empty cell.

Full Cell

The full-cell (Bethel) process is used when the retention of a maximum quantity of preservative is desired. It is a standard procedure for timbers to be treated with creosote when protection against marine borers is required. Waterborne preservatives may be applied by the full-cell process if uniformity of penetration and retention is the primary concern. With waterborne preservatives, control over preservative retention is obtained by regulating the concentration of the treating solution.

Steps in the full-cell process are essentially the following:

1. The charge of wood is sealed in the treating cylinder, and a preliminary vacuum is applied for a half-hour or more to remove the air from the cylinder and as much as possible from the wood.
2. The preservative, at ambient or elevated temperature depending on the system, is admitted to the cylinder without breaking the vacuum.
3. After the cylinder is filled, pressure is applied until the wood will take no more preservative or until the required retention of preservative is obtained.
4. When the pressure period is completed, the preservative is withdrawn from the cylinder.
5. A short final vacuum may be applied to free the charge from dripping preservative.

When the wood is steamed before treatment, the preservative is admitted at the end of the vacuum period that follows steaming. When the timber has received preliminary conditioning by the Boulton or boiling-under-vacuum process, the cylinder can be filled and the pressure applied as soon as the conditioning period is completed.

Modified Full Cell

The modified full-cell process is basically the same as the full-cell process except for the amount of initial vacuum and the occasional use of an extended final vacuum. The modified full-cell process uses lower levels of initial vacuum; the actual amount is determined by the wood species, material size, and final retention desired. The modified full-cell process is commonly used for treatment of lumber with waterborne preservatives. This publication contains pesticide recommendations that are subject to change at any time.

These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

More Water-Repellent and Non-pressure Treatments

Effective water-repellent preservatives will retard the ingress of water when wood is exposed above ground. These preservatives help reduce dimensional changes in the wood as a result of moisture changes when the wood is exposed to rainwater or dampness for short periods. As with any wood preservative, the effectiveness in protecting wood against decay and insects depends upon the retention and penetration obtained in application. These preservatives are most often applied using non-pressure treatments such as vacuum impregnation, brushing, soaking, or dipping. Preservative systems containing water-repellent components are sold under various trade names, principally for the dip or equivalent treatment of window sash and other millwork. The National Wood Window and Door Association (NWWDA) standard, WDMA I.S. 4–07A, Water Repellent Preservative Treatment for Millwork, lists preservative formulations that have met certain requirements, including EPA registration and efficacy against decay fungi.

The AWPA Commodity Specification I for non-pressure treatment of millwork and other wood products provides requirements for these non-pressure preservatives but does not currently list any formulations. The preservative must also meet the Guidelines for Evaluating New Wood Preservatives for Consideration by the AWPA for non-pressure treatment.

Water-repellent preservatives containing oxine copper are used in non-pressure treatment of wood containers, pallets, and other products for use in contact with foods. When combined with volatile solvents, oxine copper is used to pressure-treat lumber intended for use in decking of trucks and cars or related uses involving harvesting, storage, and transportation of foods (AWPA P8).

Non-pressure preservatives sold to consumers for household and farm use typically contain copper naphthentate, zinc naphthenate, or oxine copper. Their formulations may also incorporate water repellents.

Non-Pressure Processes

The numerous non-pressure processes differ widely in the penetration and retention levels of preservative attained, and consequently in the degree of protection they provide to the treated wood. When similar retention and penetration levels are achieved, wood treated by a non-pressure method should have a service life comparable to that of wood treated by pressure. Nevertheless, results of non-pressure treatments, particularly those involving surface applications, are not generally as satisfactory as those of pressure treatment. The superficial processes do serve a useful purpose when more thorough treatments are impractical or exposure conditions are such that little preservative protection is required.

Non-pressure methods, in general, consist of (a) surface application of preservatives by brief dipping, (b) soaking in preservative oils or steeping in solutions of waterborne preservatives, (c) diffusion processes with waterborne preservatives, (d) vacuum treatment, and (e) a variety of miscellaneous processes.

Brief Dipping

It is a common practice to treat window sash, frames, and other millwork, either before or after assembly, by dipping the item in a water-repellent preservative.

In some cases, preservative oil penetrates the end surfaces of ponderosa pine sapwood as much as 25 to 76 mm (1 to 3 in.). However, end penetration in such woods as the heartwood of southern pines and Douglas-fir is much less. Transverse penetration of the preservative applied by brief dipping is very shallow, usually less than a millimeter (a few hundredths of an inch). The exposed end surfaces at joints are the most vulnerable to decay in millwork products; therefore, good end penetration is especially advantageous.

Dip applications provide very limited protection to wood used in contact with the ground or under very moist conditions, and they provide very limited protection against attack by termites. However, they do have value for exterior woodwork and millwork that is painted, not in contact with the ground, and exposed to moisture only for brief periods.

Cold Soaking and Steeping

The methods of cold soaking well-seasoned wood for several hours or days in low-viscosity preservative oils or steeping green or seasoned wood for several days in waterborne preservatives have provided a range of success on fence posts, lumber, and timbers.

Pine posts treated by cold soaking for 24 to 48 h or longer in a solution containing 5% of pentachlorophenol in No. 2 fuel oil have shown an average life of 16 to 20 years or longer. The sapwood in these posts was well penetrated, and preservative solution retention levels ranged from 32 to 96 kg m–3 (2 to 6 lb in–3). Most species do not treat as satisfactorily as do the pines by cold soaking, and test posts of such woods as birch, aspen, and sweetgum treated by this method have failed in much shorter times.

Preservative penetration and retention levels obtained by cold soaking lumber for several hours are considerably better than those obtained by brief dipping of similar species. However, preservative retention levels seldom equal those obtained in pressure treatment except in cases such as sapwood of pines that has become highly absorptive through mold and stain infection.

Steeping with waterborne preservatives has very limited use in the United States but it has been used for many years in Europe. In treating seasoned wood, both the water and the preservative salt in the solution soak into the wood. With green wood, the preservative enters the water-saturated wood by diffusion. Preservative retention and penetration levels vary over a wide range, and the process is not generally recommended when more reliable treatments are practical.

Diffusion Processes

In addition to the steeping process, diffusion processes are used with green or wet wood. These processes employ waterborne preservatives that will diffuse out of the water of the treating solution or paste into the water of the wood.

The double-diffusion process developed by the Forest Products Laboratory has shown very good results in fence post tests and standard 38- by 89-mm (nominal 2- by 4-in.) stake tests, particularly for full-length immersion treatments. This process consists of steeping green or partially seasoned wood first in one chemical solution, then in another. The two chemicals then react in the wood to form a precipitate with low solubility. However, the preservatives evaluated in this process do not currently have EPA registration for use in non-pressure treatments.

Vacuum Process
The vacuum process, or “VAC–VAC” as referred to in Europe, has been used to treat millwork with water-repellent preservatives and construction lumber with waterborne and water-repellent preservatives.

In treating millwork, the objective is to use a limited quantity of water-repellent preservative and obtain retention and penetration levels similar to those obtained by dipping for 3 min. In this treatment, a quick, low initial vacuum is followed by filling the cylinder under vacuum, releasing the vacuum and soaking, followed by a final vacuum. This treatment provides better penetration and retention than the 3-min dip treatment, and the surface of the wood is quickly dried, thus expediting glazing, priming, and painting. The vacuum treatment is also reported to be less likely than dip treatment to leave objectionably high retention levels in bacteria-infected wood referred to as “sinker stock.”

Lumber intended for buildings has been treated by the vacuum process, either with a waterborne preservative or a water-repellent/preservative solution, with preservative retention levels usually less than those required for pressure treatment. The process differs from that used in treating millwork in employing a higher initial vacuum and a longer immersion or soaking period.

In a study by the Forest Products Laboratory, an initial vacuum of -93 kPa (27.5 inHg) was applied for 30 min, followed by a soaking for 8 h, and a final or recovery vacuum of -93 kPa (27.5 inHg) for 2 h. Results of the study showed good penetration of preservative in the sapwood of dry lumber of easily penetrated species such as the pines. However, in heartwood and unseasoned sapwood of pine and heartwood of seasoned and unseasoned coastal Douglas-fir, penetration was much less than that obtained by pressure treatment. Preservative retention was less controllable in vacuum than in empty-cell pressure treatment. Good control over retention levels is possible in vacuum treatment with a waterborne preservative by adjusting concentration of the treating solution.

Selecting Preservatives
The type of preservative applied is often dependent on the requirements of the specific application. For example, direct contact with soil or water is considered a severe deterioration hazard, and preservatives used in these applications must have a high degree of leach resistance and efficacy against a broad spectrum of organisms. These same preservatives may also be used at lower retentions to protect wood exposed in lower deterioration hazards, such as above the ground. The exposure is less severe for wood that is partially protected from the weather, and preservatives that lack the permanence or toxicity to withstand continued exposure to precipitation may be effective in those applications. Other formulations may be so readily leachable that they can be used only indoors.

To guide selection of the types of preservatives and loadings appropriate to a specific end use, the AWPA recently developed use category system (UCS) standards. The UCS standards simplify the process of finding appropriate preservatives and preservative retentions for specific end uses. They categorize treated wood applications by the severity of the deterioration hazard. The lowest category, Use Category 1 (UC1), is for wood that is used in interior construction and kept dry; UC2 is for interior wood completely protected from the weather but occasionally damp. UC3 is for exterior wood used above ground; UC4 is for wood used in ground contact in exterior applications. UC5 includes applications that place treated wood in contact with seawater and marine borers. Individual commodity specifications then list all the preservatives that are standardized for a specific use category along with the appropriate preservative retention.

Although some preservatives are effective in almost all environments, they may not be well-suited for applications involving frequent human contact or for exposures that present only low to moderate bio-deterioration hazards. Additional considerations include cost, potential odor, surface dryness, adhesive bonding, and ease of finish application.

Evaluating New Preservatives
Wood preservatives often need to provide protection from a wide range of wood-attacking organisms (fungi, insects, marine borers, and bacteria). Because they must protect wood in so many ways, and protect wood for a long time period, evaluating wood treatments requires numerous tests. Some of the most important tests are mentioned here, but they should be considered only as a minimum, and other tests are useful as well. Appendix A of the AWPA Standards provides detailed guidelines on the types of tests that may be needed to evaluate new wood preservatives.

The laboratory leaching test helps to evaluate how rapidly the treatment will be depleted. A treatment needs leach resistance to provide long-term protection. In this test small cubes of wood are immersed in water for 2 weeks.

The laboratory decay test is used to challenge the treated wood with certain fungal isolates that are known to aggressively degrade wood. It should be conducted with specimens that have been through the leaching test. The extent of decay in wood treated with the test preservative is compared to that of untreated wood and wood treated with an established preservative. This test can help to determine the treatment level needed to prevent decay.

Field stake evaluations are some of the most informative tests because they challenge the treated wood with a wide range of natural organisms under severe conditions. Stakes are placed into the soil in regions with a warm, wet climate (usually either the southeastern United States or Hawaii). At least two different sites are used to account for differences in soil properties and types of organisms present. The extent of deterioration in wood treated with the test preservative is compared to that of untreated wood and wood treated with an established preservative.

Above-ground field exposures are useful for treatments that will be used to protect wood above ground. Although not as severe as field stake tests, above-ground tests do provide useful information on above-ground durability. Specimens are exposed to the weather in an area with a warm, wet climate (usually either the southeastern United States or Hawaii). The specimens are designed to trap moisture and create ideal conditions for above-ground decay. The extent of deterioration in wood treated with the test preservative is compared to that of untreated wood and wood treated with an established preservative.

Corrosion testing is used to determine the compatibility of the treatment with metal fasteners. Treatability testing is used to evaluate the ability of a treatment to penetrate deeply into the wood. Shallow surface treatments rarely provide long-term protection because degrading organisms can still attack the interior of the wood.

Strength testing compares the mechanical properties of treated wood with matched, untreated specimens. Treatment chemicals or processes have the potential to damage the wood, making it weak or brittle.

Preservative Effectiveness

Preservative effectiveness is influenced not only by the protective value of the preservative chemical, but also by the method of application and extent of penetration and retention of the preservative in the treated wood. Even with an effective preservative, good protection cannot be expected with poor penetration or substandard retention levels. The species of wood, proportion of heartwood and sapwood, heartwood penetrability, and moisture content are among the important variables that influence the results of treatment.

Determining whether one preservative is more effective than another within a given use category is often difficult. Few service tests include a variety of preservatives under comparable conditions of exposure. Furthermore, service tests may not show a good comparison between different preservatives as a result of the difficulty in controlling for differences in treatment quality. Comparative data under similar exposure conditions, with various preservatives and retention levels, are included in the U.S. Forest Service, Forest Products Laboratory, stake test studies. Note, however, that because the stakes used in these studies are treated under carefully controlled conditions, their performance may not reflect variability in performance exhibited by a broad range of commercially treated material.

Effect of Species on Penetration

The effectiveness of preservative treatment is influenced by the penetration and distribution of the preservative in the wood. For maximum protection, it is desirable to select species for which good penetration is assured.

In general, the sapwood of most softwood species is not difficult to treat under pressure. Examples of species with sapwood that is easily penetrated when it is well dried and pressure treated are the pines, coastal Douglas-fir, western larch, Sitka spruce, western hemlock, western redcedar, northern white-cedar, and white fir (A. concolor). Examples of species with sapwood and heartwood somewhat resistant to penetration are the red and white spruces and Rocky Mountain Douglas-fir. Cedar poles are commonly incised to obtain satisfactory preservative penetration. With round members, such as poles, posts, and piles, the penetration of the sapwood is important in achieving a protective outer zone around the heartwood.

The proportion of sapwood varies greatly with wood species, and this becomes an important factor in obtaining adequate penetration. Species within the Southern Pine group are characterized by a large sapwood zone that is readily penetrated by most types of preservatives. In part because of their large proportion of treatable sapwood, these pine species are used for the vast majority of treated products in the United States. Other important lumber species, such as Douglas-fir, have a narrower sapwood band in the living tree, and as a result products manufactured from Douglas-fir have a lower proportion of treatable sapwood.

The heartwood of most species is difficult to treat. There may be variations in the resistance to preservative penetration of different wood species. Although less treatable than sapwood, well-dried white fir, western hemlock, northern red oak, the ashes, and tupelo are examples of species with heartwood that is reasonably easy to penetrate. The southern pines, ponderosa pine, redwood, Sitka spruce, coastal Douglas-fir, beech, maples, and birches are examples of species with heartwood that is moderately resistant to penetration.

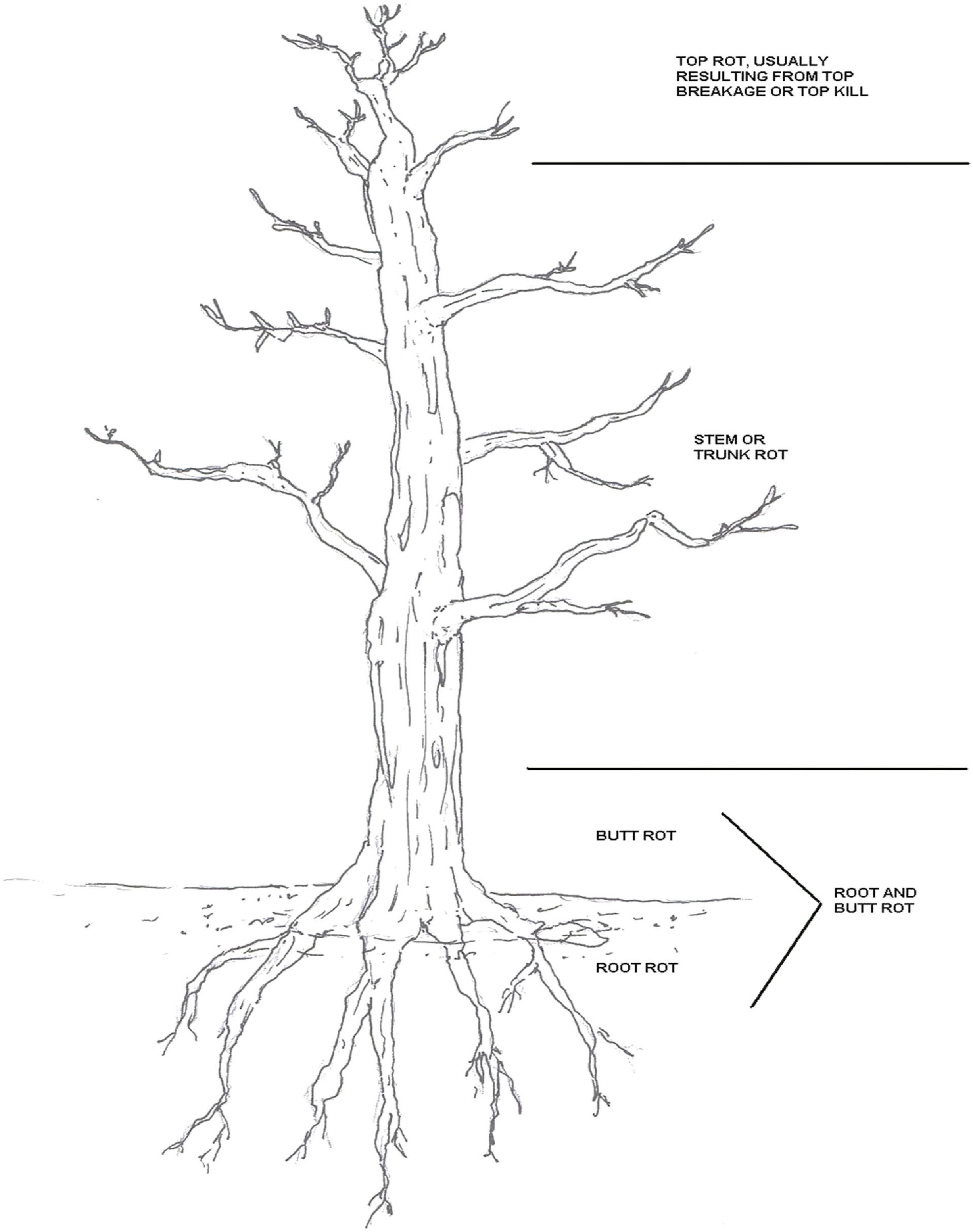
Preparation of Wood for Treatment
For satisfactory treatment and good performance, the wood product must be sound and suitably prepared. Except in specialized treating methods involving unpeeled or green material, the wood should be well peeled and either seasoned or conditioned in the cylinder before treatment. It is also highly desirable that all machining be completed before treatment, including incising (to improve the preservative penetration in woods that are resistant to treatment) and the operations of cutting or boring of holes.

Peeling
Peeling round or slabbed products is necessary to enable the wood to dry quickly enough to avoid decay and insect damage and to permit the preservative to penetrate satisfactorily. Even strips of the thin inner bark may prevent penetration. Patches of bark left on during treatment usually fall off in time and expose untreated wood, thus permitting decay to reach the interior of the member. This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

2017 Changes to EPA's Farm Worker Protection Standard

In late 2015 the Environmental Protection Agency issued the long awaited revision to the Worker Protection Standard (WPS). 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 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.


TOP ROT, USUALLY
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BREAKAGE OR TOP KILL
STEM OR
TRUNK ROT
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BUTT ROT
ROOT ROT

QUICK REFERENCE GUIDE TO THE WORKER PROTECTION STANDARD (WPS) AS REVISED IN 2015

The WPS is a federal regulation designed to protect agricultural workers (people employed in the production of agricultural plants) and pesticide handlers (people mixing, loading, or applying pesticides or doing certain tasks involving direct contact with pesticides). Each section links to the Code of Federal Regulations (40 CFR Part 170) for more information on the revised WPS. (www.ecfr.gov)

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

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

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

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

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

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

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

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

Pesticide Safety, Application and Hazard Information
An agricultural employer must display or make certain information available on the establishment. Commercial pesticide handler employers do not have to comply with information display requirements.
1. Display or make available all of the information listed in #2 together in an easily accessible ("central") location on the agricultural establishment. 170.311 (a)(5) and 170.311 (b)(2)
2. The information includes:
- EPA WPS safety poster or equivalent information, which must include some additional information by January 2, 2018, and must be kept current. 170.311 (a)
- Application information that includes:

Product name, EPA registration number, and active ingredient
Crop or site treated, location and description of the treated area
Date, start and end times of the application, and duration of restricted-entry interval (REI). 170.311 (b)(1)

- A copy of the safety data sheet (SDS) for the formulated product for each WPS-labeled pesticide applied. 170.309 and 170.311

3. In addition, display the EPA WPS safety poster (or equivalent) where decontamination supplies are located at permanent sites and where decontamination supplies are provided for 11 or more workers. 170.311 (a)(5)
4. Allow workers and handlers unrestricted access to all of the information and keep all of the displayed information current and legible. 170.311 (a)(6)-(7) and 170.311 (b)(3)-(4)
5. Display the EPA WPS safety poster or equivalent information before an application takes place and for 30 days after the REI expires. 170.309 (h)
6. Display the SDS and application information within 24 hours of the application and before workers enter treated areas. This information must be displayed for 30 days after the REI expires and kept in records on the agricultural establishment until 2 years after the REI expires. 170.309 (h)&(l) and 170.311 (b)(5)-(6)
7. Provide the SDS and application information upon request of a worker, handler, designated representative or medical personnel, within 15 days. 170.311 (b)(7)-(9)

Pesticide Safety Training

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

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

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

Decontamination Supplies

1. Establish accessible decontamination supplies located together within 1/4 mile of all **workers** (when required 170.411 (c)) and **handlers**. 170.411 and 170.509

➢ 1 gallon of water per worker and 3 gallons of water per handler at the beginning of each work period for routine and emergency decontamination,

➢ Plenty of soap and single-use towels, Note: hand sanitizers and wet towelettes are insufficient. 170.411 (b)(2) and 170.509 (b)(2)

➢ A clean coverall (or other clean change of clothes) for handlers

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

8. For **handlers**, decontamination supplies must be kept outside the treated area, or any area under an REI, unless they are protected from contamination in closed containers. 170.509 (c)(1)&(3)

Employer Information Exchange

1. Before any application, commercial pesticide handler employers must make sure the owner/ operator of an agricultural establishment where a pesticide will be applied, is aware of:

- Location and description of area to be treated,
- Date of application, estimated start time and estimated end time of the application,
- Product name, EPA registration number, active ingredient(s), and REI,
- Whether the product label requires both oral warnings and treated area posting,
- All other safety requirements on labeling for workers or other people. 170.313 (i)

2. Owners/operators of agricultural establishments must make sure any commercial pesticide

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

Emergency Assistance

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

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

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

Additional Duties for Worker Employees

These requirements apply to agricultural employers who employ workers.

Restrictions During Applications 170.405 (a)-(b)

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

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

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

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

Notice About Applications 170.409 (a)

1. Orally warn workers **and** post treated areas if required by the pesticide labeling.
2. If not, post warning signs if the REI is **greater than**:

- 48 hours for outdoor production or
- 4 hours for enclosed space production.

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

Posted Warning Signs 170.409 (b)

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

Oral Warnings 170.409 (c)

1. Before each application, tell workers who are on the establishment (in a manner they can understand):

- Location and description of treated area,
- Date and times entry is restricted
- AEZ, REI, and not to enter during REI.

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

Additional Duties for Agricultural Employers Duties

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

- The equipment may be contaminated with pesticides.
- The potentially harmful effects of pesticide exposure.
- How to handle equipment to limit exposure to pesticides.
- How to wash themselves and/or their clothes to remove and prevent exposure to pesticide residues.

170.309 (g) and 170.313 (l)

Application Restrictions and Monitoring 170.505

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

Specific Instructions for Handlers

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

Equipment Safety

1. Inspect pesticide handling equipment before each day of use, and repair or replace as needed. 170.309 (j) and 170.313 (g)
2. Allow only appropriately trained and equipped handlers to repair, clean, or adjust pesticide equipment that contains pesticides or residues, unless they are not employed on the establishment. 170.309 (g) and 170.507 (a) See Additional Agricultural Employer

Personal Protective Equipment (PPE) Handlers

Must Use

1. Provide handlers with the PPE required by the pesticide labeling, and be sure it is: 170.507 (b)

- Clean and in operating condition, 170.507 (b)
- Worn and used according to the manufacturer's instructions,170.507 (c)
- Inspected before each day of use, 170.507 (c)(2)
- Repaired or replaced as needed. 170.507 (c)(2)

2. When a respirator is required by product labeling, provide handlers with:

- A medical evaluation to ensure the handler is physically able to safely wear the respirator,
- Training in respirator use, and
- A fit test to ensure the respirator fits correctly.
- Keep records on the establishment of these items for two years. 170.507 (b)(10)

3. Take steps to avoid heat-related illness when labeling requires the use of PPE for a handler activity. 170.507 (e)
4. Provide handlers a pesticide-free area for:

- Storing personal clothing not in use,
- Putting on PPE at start of task,
- Taking off PPE at end of task. 170.507 (d)(9)

5. Do not allow used PPE to be taken home. 170.507 (d)(10)

Care of PPE

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

Replacing Respirator Purifying Elements

1. Replace particulate filters or filtering facepiece respirators when any following condition is met:

- When breathing becomes difficult,
- When the filter is damaged or torn,
- When the respirator label or pesticide label requires it,
- After 8 total hours of use, in the absence of any other instructions or indications of service life.

170.507 (d)(6)

2. Replace vapor-removing cartridges/canisters when any following condition is met:

- When odor/taste/irritation is noticed,
- When the respirator label or pesticide label requires it (whichever is shorter),
- When breathing resistance becomes excessive,
- After 8 total hours of use, in the absence of any other instructions or indications of service life.

170.507 (d)(7)

Disposal of PPE

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

Instructions for People Who Clean PPE 170.507 (d)(8)
The handler employer must inform people who clean or launder PPE:
- That PPE may be contaminated with pesticides,
- Of the potential for harmful effects of exposure to pesticides,
- How to protect themselves when handling PPE,
- How to clean PPE correctly, and
- Decontamination procedures to follow after handling contaminated PPE.

Requireme t	2017 Provision	Prior 2017 Provision
Training		
Frequency of full training for workers and handlers	Annual training.	Every 5 years.
Training grace period for worker training	No grace period. Workers must be trained before they work in an area where a pesticide has been used or a restricted-entry interval has been in effect in the past 30 days.	5-day grace period with abbreviated training.
Qualifications for trainers of workers	Certified applicators, State/Tribal/Federal approved trainers, and persons who have completed an EPA- approved train-the-trainer course.	Handlers, certified applicators, State/Tribal/Federal approved trainers, and persons completing an approved train-the-trainer course.
Expand training content for workers and handlers	Keep existing and expand content. Final worker training topics expanded to 23 items, and handler training expanded to 36 items. Training on new content not required until 2 years from effective date of final rule.	11 basic training items for workers and 13 items for handlers. Minimal training on reducing take-home exposure, reporting use violations, and prohibition from employer retaliation.
Recordkeeping of training	Keep records for 2 years. Give copy of record of training to workers and handlers upon their request.	No recordkeeping of training. Voluntary verification card system.
Hazard Communication		
Content and availability of hazard communications materials	Employer must display application information and safety data sheets (SDSs) at central location within 24 hours of end of application and before workers enter that treated area. Display both for 30 days after REI expires. Keep application information and SDS for 2 years from end of REI and make available to workers, handlers, designated representatives (identified in writing) or treating medical personnel upon request.	Employer must display application-specific information at a central location before application occurs, or, if no workers or handlers are on the establishment, before next period workers/handlers are on establishment. Keep posted for 30 days after REI expires. No recordkeeping.

Requirement	2017 Provision	Prior 2017 Provision
Notification of Treated Areas		
Notification of treated areas under an REI	Post warning sign if REI is greater than 48 hours (outdoor applications) or 4 hours (enclosed space applications (e.g., greenhouses)), otherwise option for posting or oral notification unless label requires both.	Farms, forests and nurseries: Post warning sign or give oral notification for any REI, unless label requires both. Greenhouses: all applications require signs to be posted.
Warning sign	Same as current sign.	Red circle containing stern-faced man with upraised hand. At the top: “DANGER” and “PELIGRO”, “PESTICIDES”, “PESTICIDAS”. At the bottom: “KEEP OUT”, “NO ENTRE.”

Information exchange between handler employer and agricultural employer	Agricultural employer must provide application information on treated areas the handler may be in (or walk within ¼ mile of). Handler employer must notify before the application begins for certain changes and within 2 hours of end of application for most other changes, unless only change was less than 1 hour difference in application time.	Agricultural employer must provide application information on treated areas the handler may be in (or walk within ¼ mile of). Handler employer must notify of changes to application plans before application begins.
Minimum Age		
Minimum age for handlers and early-entry workers	Handlers and early-entry workers must be at least 18 years old. (Members of owner's immediate family are exempt from this and most other requirements of the WPS.)	No minimum age.
Entry Restrictions During Application for Outdoor Production		
Ag employers must prohibit entry in areas during application for outdoor production. (Restrictions for greenhouses/enclosed space production are different.)	All outdoor production: No entry into treated area or the application exclusion zone, which is an area up to 100 feet area around the application equipment during pesticide application on farms, forests and nurseries. Size of the application exclusion zone depends on type of application. Revised descriptions of application methods.	Farms and forests: No entry into treated area. Nurseries: No entry into treated area or an area up to 100 feet around the treated area, where the size of the additional area depends on type of application.
Handler Suspend Application		
Handler (applicator) must suspend application in certain circumstances	Handler must apply pesticides so as not to contact workers or other persons. Handler must suspend application if a worker or other person is in the application exclusion zone, an area up to 100 feet around the application equipment.	Handler must apply pesticides so as not to contact workers or other persons. No specific requirement to suspend applications.
Exemptions and Exceptions		
Exemption for certified crop advisors and their employees	Only certified crop advisors are exempt from labeling PPE and WPS requirements as specified in exemption. Certified crop advisor employees must use label-required PPE while working in a field during an REI, and employer must provide all required WPS protections, or rely on the PPE substitutions allowed under the crop advisors.	Certified crop advisor chooses PPE for themselves and their employees working under their direct supervision in a field during an REI. Also exempted from providing decontamination supplies and emergency assistance for themselves and employees.

Exceptions to REIs for early entry workers – notification requirements	Notify early-entry workers of application specifics, tasks to be performed, conditions of the early-entry exception, and hazard information from the pesticide label.	Inform early-entry workers of hazard information from the pesticide label.

Requirement	2017 Provision	Prior 2017 Provision
	Basic Pesticide Safety Information	
Display of pesticide safety information	Display pesticide safety information at a central location and at sites where decontamination supplies are located, if the decontamination supplies are at a permanent site or at a location with 11 or more workers or handlers.	Display a safety poster at central location.
Content of pesticide safety information	Information can be displayed in any format (doesn't have to be a poster); keep the 7 concepts about preventing pesticides from entering your body; delete the point that there are federal rules to protect workers and handlers; add instructions for employees to seek medical attention as soon as possible if they have been poisoned, injured or made ill by pesticides; add name, address and telephone number of state or tribal pesticide regulatory authority; revise "emergency medical facility" to "*a nearby* operating medical care facility." New content for safety information display not required until 2 years from effective date of final rule.	The safety poster must include 7 concepts about preventing pesticides from entering your body; the point that there are federal rules to protect workers and handlers; and the name, address and phone number of the nearest emergency medical care facility.
	Personal Protective Equipment	
Respirators	Employer must provide respirator and fit testing, training, and medical evaluation that conforms to OSHA standards for any handler required to wear any respirator by the labeling. Require recordkeeping of completion of fit test, training, and medical evaluation.	Employer must provide respirator listed on label and ensure it fits. No recordkeeping required.
Definition of chemical-	Same as current definition.	Made of a material that allows no
PPE exception for closed systems	Exceptions to the labeling-specified PPE allowed for handlers when using closed systems. A closed system must meet a broad performance-based standard and basic operating standards (written operating instructions and training of handlers in use of the system) must be provided.	Exceptions to the labeling-specified PPE allowed for handlers when using closed systems. No specific criteria for closed systems.

PPE exception for crop advisors and their employees	Crop advisors and their employees entering treated areas while a REI is in effect to conduct crop-advisor tasks may wear a standard set of PPE (coveralls, shoes plus socks and chemical-resistant gloves made of any waterproof material, and eye protection if the labeling of the pesticide product applied requires protective eyewear for handlers, as outlined in rule), *OR* the PPE specified on the pesticide labeling for early-entry activities instead of the PPE specified on the pesticide labeling for handling activities, provided certain conditions are met. (See exemption for certified crop advisor.)	Crop advisors and their employees entering treated areas while a REI is in effect to conduct crop-advisor tasks may wear the PPE specified on the pesticide labeling for early-entry activities instead of the PPE specified on the pesticide labeling for handling activities, provided certain conditions are met. (See exemption for certified crop advisor.)
PPE exception from eyewear for pilots in open cockpits	If product label requires eye protection, pilots in open cockpits may wear a helmet with lowered face shield instead of label-required eye protection.	If product label requires eye protection, pilots in open cockpits may wear visor instead of label-required eye protection.

Requirement	2017 Provision	Prior 2017 Provision
	Personal Protective Equipment	
PPE exception from gloves for pilots in enclosed cockpits	Same as current requirement.	Gloves are optional when entering a leaving aircraft unless required by product label.
PPE exception for enclosed cabs	Maintain exception for dermal PPE as in existing rule with same conditions, but handlers in enclosed cabs must wear the labeling-specified respiratory protection except when the only labeling-specified respiratory protection is a particulate filtering facepiece respirator (NIOSH approval number prefix TC-84A), previously called a dust/mist filtering respirator.	Exceptions to the labeling-specified are allowed when handling tasks are performed from inside an enclosed c that meets the specifications defined the rule and certain conditions are m Exceptions to the labeling-required respiratory protection are allowed or the cab has been certified by the manufacturer to provide respiratory protection equivalent to the respirato protection required by the pesticide labeling for handling.
	Decontamination Supplies	
Quantity of water	Provide 1 gallon for each worker and 3 gallons for each handler and each early entry worker as measured at beginning of workers' or handlers' work period.	Provide enough water for routine washing and emergency eye flushin workers and handlers. For handlers, also provide enough to wash entire l in emergency.
Use of natural waters	Must provide water for decontamination. There is no reference to, or prohibition from, using natural waters in addition to decontamination water provided. Workers and handlers are trained to use any nearest clean water source in case of emergency.	Must provide water for decontamina May use natural waters in addition to water provided for decontamination.
Eye wash for handlers	Provide a system capable of delivering 0.4 gallons/minute for 15 minutes, or 6 gallons of water able to flow gently for about 15 minutes at a mix/load site if handlers use products requiring eye protection or use a pressurized closed system. One pint of water in a portable container must be available to each handler applying pesticides if eye protection is required.	Provide enough water for emergenc eye flushing. One pint of water in a portable container must be available each handler if eye protection is required.
	Emergency Assistance	
Emergency Assistance	Provide prompt transportation to medical facility.	Provide prompt transportation to me

Topic 5 - Wood Preservatives and Insecticides Post Quiz

Penta or Pentachlorophenol

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

Precautions and Personal Protection Measures

2. Preservatives containing copper in the form of very small particles have recently been introduced to the market, usually with "micronized" or "micro" trade names and designations such as___________.

Chromated Copper Arsenate (CCA)

3. Chromated copper arsenate (CCA) is a chemical wood preservative containing ___________.

Chemical Preservatives
Two General Classes

4. Wood preservatives have traditionally been divided into two general classes: (1) Oil-type or oil-borne preservatives, such as creosote and petroleum solutions of_______________, and (2) waterborne preservatives that are applied as water solutions or with water as the carrier.

Waterborne Preservatives

5. ___________________is the primary biocide in many wood preservative formulations used in ground contact because of its excellent fungicidal properties and low mammalian toxicity. Because some types of fungi are copper tolerant, preservative formulations often include a co-biocide to provide further protection.

6. _____________ is the most common solvent carrier in preservative formulations due to its availability and low cost. Water-borne systems do however have the drawback that they swell timber, leading to increased twisting, splitting and checking than alternatives.

Tanalith" "SupaTimber" and "Celcure"

7. CCA is widely used around the world as a_______________, often as an alternative to creosote, and pentachlorophenol. Other water-borne preservatives like CCA include alkaline copper quaternary compounds (ACQ), copper azole (CuAz), ammoniacal copper zinc arsenate (ACZA), copper citrate, and copper HDO (CuHDO)

Pressure Treatment Process

8. In the pressure treatment process, an aqueous solution of CCA is applied using a vacuum and pressure cycle, and the treated wood is then stacked to dry. During the process, the mixture of oxides reacts to form_________________, helping with leaching problems.

Other Creosotes

9. Creosotes distilled from tars other than coal tar have been used to some extent for wood preservation, although they are not included in current AWPA specifications. These include wood-tar creosote, oil-tar creosote, and water–gas-tar creosote. These creosotes provide some protection from decay and insect attack but are generally less effective than________________.

Linseed Oil

10. Linseed oil is used to preserve Wood fences, log cabins, and wood furniture. (Such woods as Willow, Pine, oak and exc.) The function of linseed oil as a preservative is believed to be related to its action as a _______________rather than a direct biocidal activity.

Answers

1. Biocidal agent, 2. MCQ or MCA, 3. Chromium, copper and arsenic, 4. Pentachlorophenol, 5. Copper, 6. Water, 7. Heavy duty preservative, 8. Insoluble compounds, 9. Coal-tar creosote, 10. Water repellent and drying agent

Topic 6 - Wood Fungus, Molds and Rot Section

Topic 6 - Section Focus: You will learn the basics of decaying wood due to disease, primarily fungus and mold destruction. At the end of this section, you will be able to describe tree and processed wood, and introduction to controlling wood rot, basic sanitation procedures (that often requires a pest control applicators licence). There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Topic 6 – Scope/Background: Wood-destroying fungus and molds are often caused by insects or moisture and therefore it is our job to control these pests and stop any forthcoming wood or food destruction. This type of control is often seen at food/wine (wine barrels, nut farms, wood used in food products, (wood cellulous) breads and many processed foods) processors /distributors or in homes where water damage or termites have started the fungus and mold process. Fungus and molds have long been used as a direct source of food, such as mushrooms and truffles, as a leavening agent for bread, and in fermentation of various food products, such as wine, beer, and soy sauce.

It takes years to properly identify and treat wood. One reason it takes years is because the chemicals changes so frequently. If you find a great chemical, it will only take a couple of years it will be replaced with some weaker form.

Wood Cellulose

Cellulose is a fiber derived from plant walls, which means it can be taken from wood and apple pulp or corn cobs. It is used in many different foods. The idea of eating powdered wood might give you pause, but food scientists say cellulose is a harmless ingredient. It occurs naturally in plant walls, which means it can be taken from wood and apple pulp or corn cobs, said John Coupland, a Penn State food scientist. We eat it whenever we consume broccoli, celery, or any other vegetable.

To make the additive, the raw fiber is chemically treated until it's refined to a microcrystalline powder or reconstituted as gum. That, in turn, is sold to food manufacturers, and companies from McDonald's to Sargento use it to thicken foods and replace fat or flour.

In the dairy industry, cellulose is used mainly as an anti-caking agent that ensures shredded cheese will "flow and not clump into a ball," when it's coming out of a shaker, said John Umhoefer, executive director of the Wisconsin Cheese Makers Association, which represents about 110 dairy manufacturers.

Tree Fungal Diseases

Plant diseases caused by fungi can be divided into four categories:

1. **Butt and root rot diseases**: It is one of the most common fungal diseases. Initially, it infects the roots, and then, it spreads to other part of the plant body. The roots decay, which later on spreads to the trunk and the branches. By the time you come to know that your plant is affected, it is too late, as the plants rot from within.
2. **Canker diseases**: If any part of a tree is injured, be it the branches or the trunk, there are chances that fungus may enter the plant causing canker disease. Initially, it infects the bark tissue, which results in the barks becoming discolored or sunken. Usually, canker infection starts from the branches and if that's the case, pruning can become an important option to prevent this disease.
3. **Shoot or foliar diseases**: The shoot or foliar disease is one of the most common tree disease caused by fungus. The most common symptom which can be seen include appearance of small spots or large blotches on the leaves and shoots. The impact can range from slight infection to the death of the plant.
4. **Vascular diseases**: In case of vascular wilts, the plant dies very soon as the fungus attacks the vascular system of the plant, thereby destroying the routes which transport nutrients and water.
5. **Identifying Tree Fungus**
   To identify the exact fungus, which affects your plant, you need to know the most common tree fungus types, which infect plants. The different types of fungi have certain characteristics with the help which you can identify them. The most common types include:
6. **Honey Fungus**
   It grows on the wood of trees in small tufts and clumps. Its cap is yellowish-brown in color and whenever moist, it's sticky to touch. Their shape ranges from convex to conical with a depression at the center, and the space depends on the age of the fungus. There may or may not be rings on the stems and have white spore prints.
7. **Beefsteak Fungus**
   It looks like a tongue and is reddish-brown in color with a rough surface. The underside is creamy-white in color and is filled with minute pores. When cut, a dull red juice comes out and the flesh looks like meat. This type is very common in sweet chestnut and oak, and usually appears in August.
8. **Tinder Fungus**
   Also called horse's hoof fungus, the tinder fungus is mostly found on birch and beech trees. It can be used to fight fire, as it can smolder for many hours. This type of fungi are hard and resilient, and they can stay alive a pretty long time. They may also develop multicolored circles and rings.

Fungus or Fungi Introduction

Fungi (kingdom Fungi) are heterotrophs. They cannot manufacture their own food as photosynthetic organisms can. Most species of fungi are saprotrophic; they decompose dead matter. Many are parasitic; they obtain nutrients from living organisms.

Fungi are the principle decomposers in every ecosystem. They can break down most organic compounds including lignin, a compound that is a major component of wood and is very difficult to break down or digest. Some species are parasites and others are mutualistic. The main wood-inhabiting group of basidiomycetes are commonly known as the polypores.

It's estimated that in North America, no less than 100 species of polypores cause decay in woody plants and timber, while approximately 75 species are responsible for 90% of the important decays produced in timber and wood products. Most polypores are saprophytic and utilize dead wood as their food source. These fungi commonly appear as hard, tough, corky, leathery or woody structures of various shapes and sizes (see figure 1). They have a fertile surface (where spores are produced), usually made of pores or tubes closely packed together.

Polypores are mostly wood inhabiting fungi that are able to utilize components of wood as their primary source of energy for growth and reproduction. When a fruiting body is seen on wood, the mycelium, or main body of the fungus, is usually not so visible, growing within the wood obtaining nutrients from it.

They have extracellular digestion by secreting enzymes into environment and absorbing the nutrients produced. Fungi store their food as glycogen (like animals). Plants and green algae store their food as starch. Shelf fungi are particularly important in breaking down wood.

CLASSIFICATION OF LIVING THINGS							
DOMAIN	BACTERIA	ARCHAEA	EUKARYA				
KINGDOM	EUBACTERIA	ARCHAEBACTERIA	PROTISTS	FUNGI	PLANTAE	ANIMALIA
CELL TYPE	PROKARYOTE	PROKARYOTE	EUKARYOTE	EUKARYOTE	EUKARYOTE	EUKARYOTE
CELL STRUCTURES	CELL WALLS WITH PEPTIDOGLYCAN	CELL WALLS WITHOUT PEPTIDOGLYCAN	CELL WALLS OF CELLULOSE IN SOME; SOME HAVE CHLOROPLASTS	CELL WALLS OF CHITIN	CELL WALLS OF CELLULOSE; CHLOROPLASTS	NO CELL WALLS OR CHLOROPLASTS
NUMBER OF CELLS	UNICELLULAR	UNICELLULAR	MOST UNICELLULAR; SOME COLONIAL; SOME MULTICELLULAR	MOST MULTICELLULAR; SOME UNICELLULAR	MULTICELLULAR	MULTICELLULAR
MODE OF NUTRITION	AUTOTROPH OR HETEROTROPH	AUTOTROPH OR HETEROTROPH	AUTOTROPH OR HETEROTROPH	HETEROTROPH	AUTOTROPH	HETEROTROPH
EXAMPLES	STREPTOCOCCUS, ESCHERICHIA COLI	METHANOGENS, HALOPHILES	AMOEBA, PARAMECIUM, SLIME MOLDS, GIANT KELP	MUSHROOMS, YEASTS	MOSSES, FERNS, FLOWERING PLANTS	SPONGES, WORMS, INSECTS, FISHES MAMMALS

A fungus or fungi is a member of a large group of eukaryotic organisms that includes microorganisms such as yeasts and molds, as well as the more familiar mushrooms. These organisms are classified as a kingdom, Fungi, which is separate from plants, animals, and bacteria. One major difference is that fungal cells have cell walls that contain chitin, unlike the cell walls of plants, which contain cellulose. These and other differences show that the fungi form a single group of related organisms, named the Eumycota (true fungi or Eumycetes), that share a common ancestor (a monophyletic group). This fungal group is distinct from the structurally similar myxomycetes (slime molds) and oomycetes (water molds).

The discipline of biology devoted to the study of fungi is known as mycology, which is often regarded as a branch of botany, even though genetic studies have shown that fungi are more closely related to animals than to plants.

Abundant worldwide, most fungi are inconspicuous because of the small size of their structures, and their cryptic lifestyles in soil, on dead matter, and as symbionts of plants, animals, or other fungi. They may become noticeable when fruiting, either as mushrooms or molds.

Fungi perform an essential role in the decomposition of organic matter and have fundamental roles in nutrient cycling and exchange. They have long been used as a direct source of food, such as mushrooms and truffles, as a leavening agent for bread, and in fermentation of various food products, such as wine, beer, and soy sauce.

Mycotoxins

Since the 1940s, fungi have been used for the production of antibiotics, and, more recently, various enzymes produced by fungi are used industrially and in detergents. Fungi are also used as biological pesticides to control weeds, plant diseases and insect pests. Many species produce bioactive compounds called mycotoxins, such as alkaloids and polyketides that are toxic to animals including humans. The fruiting structures of a few species contain psychotropic compounds and are consumed recreationally or in traditional spiritual ceremonies.

Fungi can break down manufactured materials and buildings, and become significant pathogens of humans and other animals. Losses of crops due to fungal diseases (e.g. rice blast disease) or food spoilage can have a large impact on human food supplies and local economies.

The fungus kingdom encompasses an enormous diversity of taxa with varied ecologies, life cycle strategies, and morphologies ranging from single-celled aquatic chytrids to large mushrooms. However, little is known of the true biodiversity of Kingdom Fungi, which has been estimated at around 1.5 million species, with about 5% of these having been formally classified.

Ever since the pioneering 18th and 19th century taxonomical works of Carl Linnaeus, Christian Hendrik Persoon, and Elias Magnus Fries, fungi have been classified according to their morphology (e.g., characteristics such as spore color or microscopic features) or physiology. Advances in molecular genetics have opened the way for DNA analysis to be incorporated into taxonomy, which has sometimes challenged the historical groupings based on morphology and other traits. Phylogenetic studies published in the last decade have helped reshape the classification of Kingdom Fungi, which is divided into one subkingdom, seven phyla, and ten subphyla.

Reproduction

Fungal reproduction is complex, reflecting the differences in lifestyles and genetic makeup within this kingdom of organisms. It is estimated that a third of all fungi reproduce by different modes of propagation; for example, reproduction may occur in two well-differentiated stages within the life cycle of a species, the teleomorph and the anamorph.

Environmental conditions trigger genetically determined developmental states that lead to the creation of specialized structures for sexual or asexual reproduction. These structures aid reproduction by efficiently dispersing spores or spore-containing propagules.

Asexual Reproduction

Asexual reproduction via vegetative spores (conidia) or through mycelial fragmentation is common; it maintains clonal populations adapted to a specific niche, and allows more rapid dispersal than sexual reproduction. The "Fungi imperfecti" (fungi lacking the perfect or sexual stage) or Deuteromycota comprise all the species which lack an observable sexual cycle.

Sexual Reproduction

Sexual reproduction with meiosis exists in all fungal phyla (with the exception of the Glomeromycota). It differs in many aspects from sexual reproduction in animals or plants. Differences also exist between fungal groups and can be used to discriminate species by morphological differences in sexual structures and reproductive strategies. Mating experiments between fungal isolates may identify species on the basis of biological species concepts. The major fungal groupings have initially been delineated based on the morphology of their sexual structures and spores; for example, the spore-containing structures, asci and basidia, can be used in the identification of ascomycetes and basidiomycetes, respectively. Some species may allow mating only between individuals of opposite mating type, while others can mate and sexually reproduce with any other individual or itself. Species of the former mating system are called heterothallic, and of the latter homothallic.

Most fungi have both a haploid and diploid stage in their life cycles. In sexually reproducing fungi, compatible individuals may combine by fusing their hyphae together into an interconnected network; this process, anastomosis, is required for the initiation of the sexual cycle. Ascomycetes and basidiomycetes go through a dikaryotic stage, in which the nuclei inherited from the two parents do not combine immediately after cell fusion, but remain separate in the hyphal cells (see heterokaryosis).

In ascomycetes, dikaryotic hyphae of the hymenium (the spore-bearing tissue layer) form a characteristic hook at the hyphal septum. During cell division, formation of the hook ensures proper distribution of the newly divided nuclei into the apical and basal hyphal compartments. An ascus (plural asci) is then formed, in which karyogamy (nuclear fusion) occurs. Asci are embedded in an ascocarp, or fruiting body. Karyogamy in the asci is followed immediately by meiosis and the production of ascospores. After dispersal, the ascospores may germinate and form a new haploid mycelium.

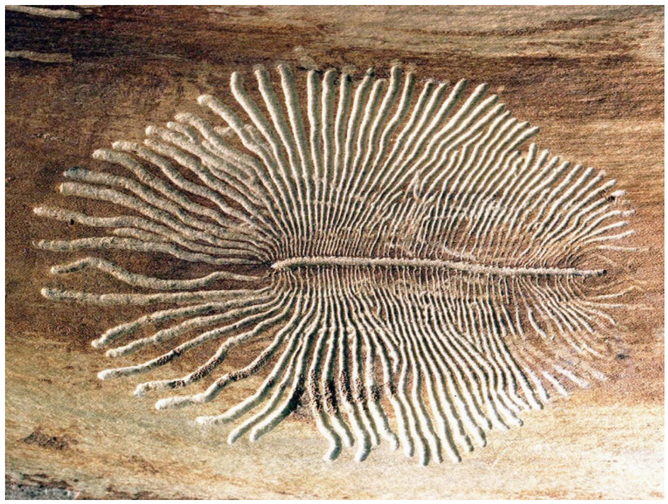
Sexual reproduction in basidiomycetes is similar to that of the ascomycetes. Compatible haploid hyphae fuse to produce a dikaryotic mycelium. However, the dikaryotic phase is more extensive in the basidiomycetes, often also present in the vegetatively growing mycelium.

A specialized anatomical structure, called a clamp connection, is formed at each hyphal septum. As with the structurally similar hook in the ascomycetes, the clamp connection in the basidiomycetes is required for controlled transfer of nuclei during cell division, to maintain the dikaryotic stage with two genetically different nuclei in each hyphal compartment.

A basidiocarp is formed in which club-like structures known as basidia generate haploid basidiospores after karyogamy and meiosis. In glomeromycetes (formerly zygomycetes), haploid hyphae of two individuals fuse, forming a gametangium, a specialized cell structure that becomes a fertile gamete-producing cell. The gametangium develops into a zygospore, a thick-walled spore formed by the union of gametes. When the zygospore germinates, it undergoes meiosis, generating new haploid hyphae, which may then form asexual sporangiospores. These sporangiospores allow the fungus to rapidly disperse and germinate into new genetically identical haploid fungal mycelia.

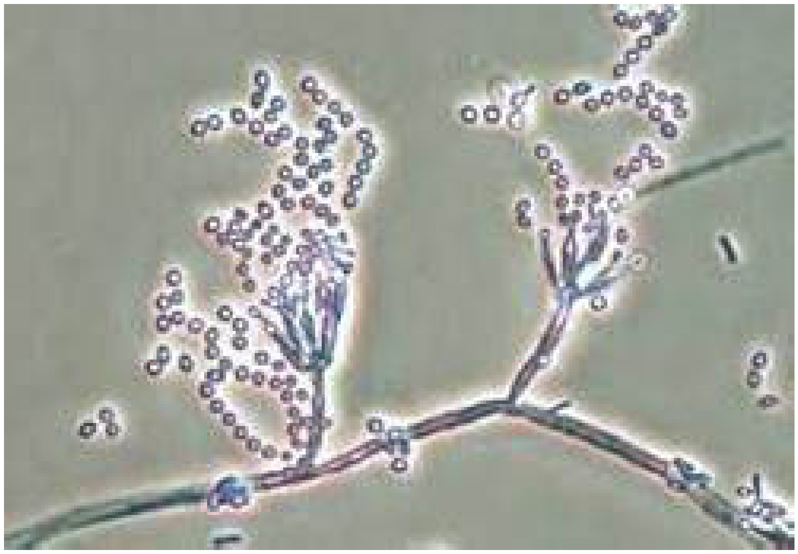
Plant Pathogens and Parasites

Many fungi are parasites on plants, animals (including humans), and other fungi. Serious pathogens of many cultivated plants causing extensive damage and losses to agriculture and forestry include the rice blast fungus Magnaporthe oryzae, tree pathogens such as Ophiostoma ulmi and Ophiostoma novo-ulmi causing Dutch elm disease, and Cryphonectria parasitica responsible for chestnut blight, and plant pathogens in the genera Fusarium, Ustilago, Alternaria, and Cochliobolus.



OPHIOSTOMA ULMI

DUTCH ELM DISEASE



PAECILOMYCES LILACINUS UNDER MICROSCOPE

Carnivorous Fungi
Some carnivorous fungi, like Paecilomyces lilacinus, are predators of nematodes, which they capture using an array of specialized structures such as constricting rings or adhesive nets.

Spores
All fungi produce spores (which are like tiny seeds) that are distributed by wind and water. The spores can infect moist wood during storage, processing, and use.

Spore Dispersal
Both asexual and sexual spores or sporangiospores are often actively dispersed by forcible ejection from their reproductive structures. This ejection ensures exit of the spores from the reproductive structures as well as travelling through the air over long distances.Specialized mechanical and physiological mechanisms, as well as spore surface structures (such as hydrophobins), enable efficient spore ejection. For example, the structure of the spore-bearing cells in some ascomycete species is such that the buildup of substances affecting cell volume and fluid balance enables the explosive discharge of spores into the air.

The forcible discharge of single spores termed ballistospores involves formation of a small drop of water (Buller's drop), which upon contact with the spore leads to its projectile release with an initial acceleration of more than 10,000 g; the net result is that the spore is ejected 0.01–0.02 cm, sufficient distance for it to fall through the gills or pores into the air below.

Other fungi, like the puffballs, rely on alternative mechanisms for spore release, such as external mechanical forces. The bird's nest fungi use the force of falling water drops to liberate the spores from cup-shaped fruiting bodies. Another strategy is seen in the stinkhorns, a group of fungi with lively colors and putrid odor that attract insects to disperse their spores.

All Fungi have certain Basic Requirements

Favorable temperatures (usually ranging between 50 and 90 degrees F. The optimum is about 70 to 85 degrees F. Wood is basically safe from decay at temperatures below 35 and above 100 degrees F.

- Adequate moisture (fungi will not attack dry wood (i.e., with a moisture content of 19 percent or less).
- Decay fungi require a wood moisture content (M.C.) of about 30 percent (the generally accepted fiber saturation point of wood). Thus, air-dried wood, usually with an M.C. not exceeding 19 percent, and kiln-dried wood, with an M.C. of 15 percent or less, may be considered safe from fungal damage.
- Adequate oxygen—most fungi cannot live in water-saturated wood.
- Food source—wood substance (cellulose, hemicellulose, lignin).

Wood Decaying Fungi
The sapwood and heartwood of most tree species are susceptible to decay. Decay fungi grow in the interior of the wood or appear on wood surfaces as fan-shaped patches of fine, threadlike, cottony growths or as rootlike shapes. The color of these growths may range from white through light brown, bright yellow, and dark brown.

WOOD FUNGUS EXAMPLE

The spore-producing bodies are the fruiting bodies of the fungus and may take the form of mushrooms, shelf like brackets, or flattened, crust like structures. Fine, threadlike fungal strands called mycelia grow throughout the wood and digest parts of the wood as food. In time, the strength and other properties of the wood are destroyed.

PLEUROTUS ON LIVING TREE

Once decay has started in a piece of wood, the rate and extent of deterioration depend on the duration of favorable conditions for fungal growth. Decay will stop when the temperature of the wood is either too low or too high or when the moisture content is lower than the fungi's requirements.

Decay can resume when the temperature and moisture content become favorable again. Early decay is more easily noted on freshly exposed surfaces of unseasoned wood than on wood that has been exposed and discolored by the weather.

Three Major Categories
Wood decay fungi can be grouped into three major categories: brown rot, white rot, and soft rot. We will examine these in a few more pages.

Wood Rot Sub-Section

Portions of this section are credited to "Ohio State University Extension, author William F. Lyon

Many homeowners are familiar with wood damage caused by rot. They see it in structural lumber, log homes, eaves, garage doors, exterior door trim, window casings and other wood used in construction.

WHITE ROT EXAMPLE

Current estimates show that replacement materials, needed to repair damage caused by rot alone, account for nearly 10 percent of U.S. annual wood production. Wood decay is a deterioration of wood by primarily enzymatic activities of microorganisms. For practical purposes, fungi are the only agents of wood decay. There are other kinds of deterioration, by insects, marine animals, UV, but this is not decay, nor is it quantitatively as important as decay.

Blame for this destruction is sometimes incorrectly placed on termites or other wood-destroying insects. However, there are no mud tunnels or mines in the wood such as seen with termite and other wood-destroying insects, nor is there any sawdust, which would be evident in the case of carpenter ant damage.

This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded.

Preventing Rot
The key to preventing rot is to control the wood's exposure to moisture and to employ an effective prevention and treatment program. Most wood decay fungi grow only on wood with a high moisture content, usually 20 percent or above. Green (unseasoned) lumber is a prime target for decay fungi.

Identification
There are three types of wood rot: brown rot, white rot and soft rot, we will go more into detail and there are two main classifications. Brown rot causes wood to split and crumble by cracking it against the grain. Advanced stages of brown rot result in dry, powdery wood that is unable to support any weight and crumbles easily.

White rot causes wood to take on a gray, white or yellowish color and can result in stringy or spongy wood. Soft rot is less common and typically only attacks wood shingles in wet areas. All three types of wood rot can result in significant structural damage.

Fungi are a major cause of wood degradation. Fungi used to be classified in the plant kingdom but are now classified in a kingdom separate from plants and animals. Like animals, fungi are heterotrophic—i.e., they must consume preformed organic matter rather than manufacture their own food as plants do during photosynthesis.

Fungi consist of microscopic threads called hyphae that are visible to the naked eye only when many of them occur together. Deadwood conks and mushrooms are easily visible examples of the fruiting bodies of fungi from which the reproductive spores are produced and disseminated. Some fungi merely discolor wood, but wood-decaying fungi can change the physical and chemical properties of wood, thus reducing its strength. Therefore, the many wood-inhabiting fungi can be divided into two major groups, depending on the damage they cause: Wood-decaying fungi (wood-rotting fungi) and Wood-staining fungi (sap staining fungi, molds).

Decay Fungi
Decay fungi can cause severe structural damage to any wood member, even wood species such as redwood and cedar. All that is needed is a source of water in contact with the wood. Decay will occur in untreated wood in direct contact with ground, cement or concrete, or exposed to a source of moisture such as rain seepage, plumbing leaks or condensation. Wood kept dry will never decay!

Brown Rot
Brown rot fungi feed on the wood's cellulose, a component of the wood's cell wall, leaving a brown residue of lignin, the substance which holds the cells together. Infested wood may be greatly weakened, even before decay can be seen. Advanced infestations of brown rot are evidenced by wood more brown in color than normal, tending to crack across the grain. When dried, wood previously infested will turn to powder when crushed. Often, old infestations of brown rot which have dried out are labeled as "dry rot." This is really a deceiving term since wood will not decay when dry.

Brown rot is brown because carbohydrates are removed, leaving brownish, oxidized lignin. There is no fibrous texture because the cellulose is broken up early. The wood shrinks on drying and cross-checking is seen in later stages. It is often called "cubical" brown rot for that reason.

There are a handful of "brown pocket rots." They only occur in living trees, and more specifically trees that have unusually durable wood, with otherwise effective antifungal chemicals in the heartwood. One can speculate that the occurrence of brown pocket rots in such tree species is probably related to the chemical protection of the wood, but how is a mystery that is yet to be solved.

The initial stage is non-enzymatic. Fungus produces some small chemical agent (involving oxalic acid and hydrogen peroxide) that zips around in the cell wall like a little pair of scissors, snipping chains of cellulose and hemicellulose into smaller pieces. This happens throughout the wall in fairly early stages. The carbohydrates become partly soluble, enzymes work on them, releasing sugars, and they are slowly absorbed by the fungus.

More on White Rot
When white rot attacks wood, it breaks down both the lignin and cellulose causing the wood to lose its color and appear whiter than normal. Wood affected by white rot normally does not crack across the grain and will only shrink and collapse when severely degraded. Infested wood will gradually lose its strength and become spongy to the touch.

WHITE ROT EXAMPLE #2

White rot is fibrous because some cellulose remains intact till very late stages. It is typically less fibrous in hardwoods than in softwoods because of the shorter fibers in hardwoods. It usually turns whitish because of bleaching by oxidation and loss of lignin, which is slightly brown.

Color and texture vary among white rots caused by different fungi:

- Stringy white rot
- Spongy white rot
- Laminated white rot (separation of annual rings)
- Mottled white rot
- White pocket rot
- Zone lines sometimes present

In some white rots, there is a phenomenon called selective delignification. All components are removed, but the relative rate varies. Lignin and hemicelluloses are selectively removed in early stages. This leaves enriched cellulose. This is what happens in the white regions of a mottled rot and in the pockets of a white pocket rot. There is a tremendous amount of interest in using these fungi in industry, because many uses of wood involve removing lignin (e.g., bio-pulping).

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.

Water-Conducting Fungi

Most decay fungi are unable to conduct water very far and can only attack moist wood. However, *Poria incrassata*, called dry rot or the water-conducting fungus, will decay wood which would not be attacked by typical decay fungi. Poria infested wood is often mistakenly identified as subterranean termite damage. This type of fungus can transport water for several feet through large root-like structures called rhizomorphs. Once established, it can quickly spread through a building and destroy large areas of flooring and walls in as little as a year or two.

Typically, infestations of Poria begin in dirt filled porches, damp crawl spaces and basements where wood is in contact with the soil. They also begin in moist concrete or damp bricks. At first, yellowish mycelial fans grow over the surface of joists and sub-floors, or in protected areas.

Rhizomorphs

Irregular root-like rhizomorphs may appear on foundations, framing, sub flooring and other moist areas. The rhizomorphs are dirty white when young but turn brown to black with age. They are typically 1/4 to 1/2 inch wide, but can be an inch or more in diameter in old infestations. They are often hidden in concrete, masonry or behind wood structures. Fruiting bodies do not always form, but when they do they are found on well-rotted wood and are flat, up to 1/2 inch thick, and pale olive-gray with a dirty white/yellow rim when young. With age they become dry and turn brown to black. The under surface is covered with small pores.

WHITE RHIZOMORPHS

PORIA INFESTED DRY WOOD- PORIA INFESTATION

When Poria infested wood dries it usually shrinks and cracks across the cracks or depressed areas in painted woodwork may be the first evidence of a Poria infestation. The best tool for discovering a Poria infestation is a moisture meter.

If wood has a moisture content above 40% and there is no apparent source of water, you are probably confronting Poria incrassata or an infestation of subterranean termites. In either case the wood should be treated as soon as possible.

Molds and Stains

Molds and stain fungi are sometimes mistaken for decay, and while they may discolor wood, they cause no structural wood damage. The presence of molds and stains, however, is a sign that conditions are favorable for decay fungi and a preventative treatment may be necessary. In addition, molds can increase the capacity of wood to absorb moisture, opening the door to attack by decay fungi. More on mold in a few pages.

Brown Discoloration and a Crumbly Appearance
In one type of rot, the decayed area has a brown discoloration and a crumbly appearance. It usually breaks up into variously-sized cubes, giving rise to the name "brown cubical rot." Another type of rot results in a white or yellow discoloration, with the decayed wood being "stringy" or "spongy."

Although many decay fungi may grow for long periods without producing any external evidence of their presence, others produce "fruiting bodies" on the surface of decaying wood. Fruiting bodies are usually "crusts" or shelf-like "brackets" which are a few inches or so in diameter. The fruiting body of *Serpula lacrimans*, e.g., is a rust-brown, crust-like structure on the wood surface.

It has a waxy appearance, with shallow, net-like folds or "wrinkles." The fruiting body of Poria incrassata is also crust-like. It is white to light buff when initially formed, but becomes brown as it ages and dries out. Small pores can be seen in the crust when it is examined with a hand lens. *Gleophyllum trabeum* forms bracket-like fruiting bodies. The upper surface of the fruiting body is dull gray-brown and smooth. The lower surface has elongate openings (pores) or split-like openings (gills). These fruiting bodies produce millions of tiny spores which may, in some cases, serve to spread the decay fungus to other areas.

Stain Fungi
Also, surface molds, "mildews," and stain fungi are often found growing on the surface of damp wood and can be confused with decay fungi. Although these organisms may discolor the wood, they do not break down wood fibers and thus do not weaken its structure. However, these organisms indicate that moisture is present and that decay will likely proceed if a wood-rotting fungus becomes established in the wood.

Brown rot commonly attacks softwoods turning the wood dark brown. In advanced stages of decay, wood attacked by brown rot becomes friable and splits appear across the grain giving the wood a "checkerboard" appearance. Infested wood may be structurally weakened in a relatively short period of time.

Once brown rot has extracted all of the nutrients from the wood the wood may become dry and powdery. This leaves the impression that dry wood has rotted (dry rot) but in reality it is an old infestation of brown rot.

One of the most destructive types of brown rot fungi is poria incrassata, otherwise known as the water-conducting fungus. This type of fungus actually transports water through root-like structures known as rhizomorphs. Infestations of poria incrassata can progress quite rapidly destroying portions of flooring and wood members in a year or two.

One indication of a poria incrassata infestation is the presence of rot in wood with no visible source of water. A moisture meter is the best tool is determining the extent of an infestation. Any wood having a moisture content in excess of 40% without an apparent source of water may well be infected with poria incrassate.

Terms for Position of Decays
In general, live trees tend to decay from the inside out and dead trees from the outside in. There are various reasons for this, but it is largely due to the fact that sapwood has a very effective active resistance when the tree is alive but virtually no resistance once the tree is dead. The terms relating to position of decay in the tree are just approximations; the fungi are not necessarily restricted to these regions.

In addition to the terms at the left, two that you run into are heart rot and sap rot. Heart rot is often defined as decay in living trees. Some define it as decay that develops primarily in the heartwood or inner wood of living trees. It is usually used to refer to decays that primarily develop in the stem rather than in the roots and butt. Sap rot may refer to saprobic decays or to those that develop in the sapwood. Usually sapwood decays extensively only in dead trees. But there are some fungi that commonly decay sapwood in living trees, usually causing cankers.

Also keep in mind that saprobic fungi can and do decay heartwood in dead trees. Here we use the term stem decay for all diseases where the primary symptom is decay of stem wood, largely because 'heart rot' is thought by some to imply that decay is restricted to heartwood, which is frequently not the case.

Life Cycle & Habits
Decay fungi are living organisms which send minute threads called "hyphae" through damp wood, taking their food from the wood as they grow. Gradually, the wood is decomposed and its strength is lost. Such damage is often inconspicuous until its final stages, and in a few instances homeowners have suddenly found floors breaking through or doors falling from their hinges due to wood rot. When previously dry wood is placed in contact with moist soil, or in a location where it is subject to condensation (such as unventilated crawl space), it is likely that wood decay problems will occur.

Rain leaks, faulty plumbing and leaky downspouts also are common sources of moisture. In some instances, water can be transported to the site of decay through strands or "rhizomorphs" of the decay fungi. Water-transporting strands may extend for thirty or more feet across brick, concrete or similar materials.

SERPULA LACRIMANS

The wood decay fungus, Serpula lacrimans, has been known to transport water up three stories to an area where decay is occurring. Poria incrassata is also capable of transporting water long distances. However, these fungi are exceptions to the rule. Most wood-rotting fungi must have a direct supply of water at the site of decay. Thus the term "dry-rot," sometimes applied to decay in wood structures, is erroneous.

This rot has a perfect condition to thrive, it is wrapped by vinyl siding and allows enough rain water to keep the wood moist.

Misconceptions

- ✓ Wood rot is often blamed on termites or other insects, but only water and fungi cause this type of damage. Termites and other insects are responsible for some cases of wood damage, but the symptoms of termite or insect damage differ from those of wood rot and include tunnels or mines in the wood and sawdust. Additionally, there is no such thing as dry rot. Dry wood is not susceptible to wood rot and damage caused by wood rot is only found in wood that is either currently wet or has been previously exposed to water.

BROWN ROT EXAMPLE

Warning

Wood rot is often not detected until the amount of damage is considerable. Unless a thorough home inspection is done periodically, rot may grow inside the wood of a home until the entire structure is compromised. The more widespread the rot, and the longer the decay remains untreated, the more extensive the damage and the more difficult the repair process.

Fire Scars

Early studies suggested that fire scars are the most important, both in hardwoods of SE and in conifers of the west. Not sure if that is still true today.

Wounds

Broken tops (from glaze or snow storms, leading to top rot), treefall scars, animal damage (such as deer scraping off velvet, cattle damage to root collar, even bears in one case), logging scars, carving and hatchet marks. Logging injuries are an important infection court that we can manage to reduce heart rot. Damage from pruning can be minimized by knowing how to prune.

Branch Stubs

Even dead twigs down to few mm diam. can be infection court for some fungi, such as Phellinus pini. Same fungus also can infect through white pine leaders killed by white pine weevil. Stubs/twigs also important for Stereum sanguinolentum, Echinodontium tinctorium.

The Rusts *(Not found in wood but may be in food)*

The rusts belong to the Basidiomycota, the division of fungi to which the mushrooms belong. Although the rusts attack a large number of seed plants and even some ferns, it is the rusts' diseases on the various grains that have been most frequently described in historical records.

BASIDIOMYCOTA EXAMPLE

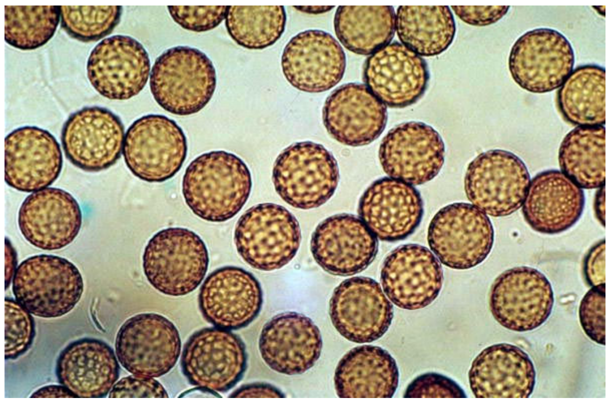
The common name rusts is based on the "rusty" colored blotches that is present on the stems and leaves from the urediospore stage in this group of fungi. Recent archeological digs in Israel discovered spores of Wheat Rust on grains dating back at least 3000 years. Rusts diseases, along with a few other types of plant diseases, have clearly been recorded in the Bible, and the ancient Greek writings of Aristotle, and his student Theophrastus, who has been called the father of botany because of his early contributions to plant science.

In his Historia Plantarum (History of Plants), Theophrastus described rusts on grain crops, in meticulous details, twenty two centuries ago. The Greeks and Romans actually made a good start in attempting to understand plant diseases. However, the dark ages soon followed and it would be a thousand years before progress in understanding of diseases would be made. Even as recently as 1800, it was believed that fungi found on diseased plants were part of the dying tissue of the sick plant, and it would not be until 1861 that Anton de Bary would demonstrate, conclusively that the Late Blight of Potato disease was due to the fungal pathogen, Phytophthora infestans.

Before describing some of the impact that this group of diseases has had and continues to have on the world, let us look into the uniqueness of the life history of this fungus. Unlike most parasitic fungi, or fungi in general, the rusts do not have only one spore (sexual or asexual), or two spore (sexual and asexual) stages and a single host, they may have as many as five spore stages and may have two hosts.

Stomata
Entry into the host occurs when the spores germinates and enters the plant through openings called stomata. Stomata are pores on the surface of the herbaceous parts of plants that allow for gas exchange to occur.

However, these openings also provide an avenue for pathogens such as the rust fungi to enter. Once entry into the wheat plant has been accomplished, mycelium will grow and begin to absorb nutrient from the plant. The mycelium in the host plant will give rise to clusters of urediospores, with each cluster being produced in a uredium.



UREDIOSPORES

As the urediospores develop, they will burst the epidermis, exposing the characteristic, rusty-colored urediospores on the surface of the plant. This stage is a "repeater stage" and is the most damaging to the wheat. The urediospore can infect other wheat plants throughout the spring and early summer. During late summer, just before fall, the uredium gradually converts into the telium and begin to produce the two-celled, thick-walled teliospores.

Smut - the "Dirty" Fungus

The literal meaning of smut is "dirt or excrement". However, it has come to mean something that is "filthy or obscene". Like the rust fungi, the smut fungus is also a member of the division Basidiomycota, do not produce fruiting bodies and produce basidia and basidiospores from germination of the teliospore. However, unlike the rusts, the plant pathologists' war against the smuts have been a successful one.

BASIDIOMYCOTA EXAMPLE #2

Although no mention is specifically made of this group of disease until 1700, most plant pathologists agree that with the number of spores that are produced by the fungus and the number of species that grow on crop plants that smut must surely have been known since the onset of agriculture.

Mathieu Tillet, a keeper of the mint, in France, was a man of many interests. One of these included studying the problems of farmers. In 1755, while observing the smuts on Wheat, Tillet discovered that there were two types of smut growing on Wheat: La carie or what the English called "Common Bunt" or "Stinking Smut".

Grains infected with this type of smut seemed healthy, at first glance, but grains were actually filled with brownish balls full of a black, foul-smelling powder. In the second type of smut, the plants looked healthy enough, but were covered with a loose, black powder that readily blew away.

Tillet called this le charbon or what the English called "loose smut". The distinction between the two types of smut was verified a century later, in 1847, by Louis and Charles Tulasne. To honor Tillet, they named the "Stinking Smut" Tilletia caries.

Disease Cycle of Decays
Refer to the life cycle of a polypore, as it is closely related to the disease cycle. Two points need to be added. First, decay occurs for many years, between the stages of plasmogamy and fruiting, and fruiting may continue for many years. Second, dispersal and infection court are important issues:

Dispersal is by Spores

- ✓ Spores may be released for a few days (mushrooms) or for six months or more per year (perennial conks).
- ✓ Up to 300 billion spores per day are produced by some conks!
- ✓ The spores are carried by wind. They are in suspension in air and can travel many miles even in light breeze.
- ✓ Some decay fungi have a conidial stage in culture but those are rarely found in nature and their importance is unknown.
- ✓ Infection court is invariably non-living wood

MISTLETOE

Cankers, Mistletoe infections, Necrotic Galls
These sites may eventually become infected by decay fungi, which may lead to stem breakage.

Wood Lichens VS Fungi

These interesting organisms, however, do not cause disease problems. They live and gather sunlight on twigs or branches but do not infect the tree. Many lichens grow rapidly when exposed to full sunlight, which explains their common occurrence on dead or dying trees. In addition to growing on tree parts, lichens can be found on dead wood, rocks, soil, tombstones, or other sunny places.

LICHENIZED FUNGI

Lichens occur in some of the most extreme environments on Earth—arctic tundra, hot deserts, rocky coasts, and toxic slag heaps. However, they are also abundant as epiphytes on leaves and branches in rain forests and temperate woodland, on bare rock, including walls and gravestones, and on exposed soil surfaces (e.g., Collema) in otherwise mesic habitats. Lichens are widespread and may be long-lived; however, many are also vulnerable to environmental disturbance, and may be useful to scientists in assessing the effects of air pollution, ozone depletion, and metal contamination. Lichens have also been used in making dyes and perfumes, as well as in traditional medicines.

BRYORIA PSEUDOCAPILLARIS

There are two different lichens on this branch, one looks like moss and the other like a plant. The mossy looking one may be Bryoria pseudocapillaris, difficult to correctly discern since there is so many different and similar lichens. Typically, they occur in abundance on plants that are declining in health or vigor. They are in no way responsible for the poor health of the plant. Less vigorous plants tend to be more open, increasing sunlight penetration and subsequent lichen growth.

Controls are not necessary, since lichens are not harming the plant. Lichens will gradually disappear if plant health is restored. Remember they will probably reappear if you do not correct the true cause of the plant's decline. Living as a symbiont in a lichen appears to be a very successful way for a fungus to derive essential nutrients, as about 20% of all fungal species have acquired this mode of life.

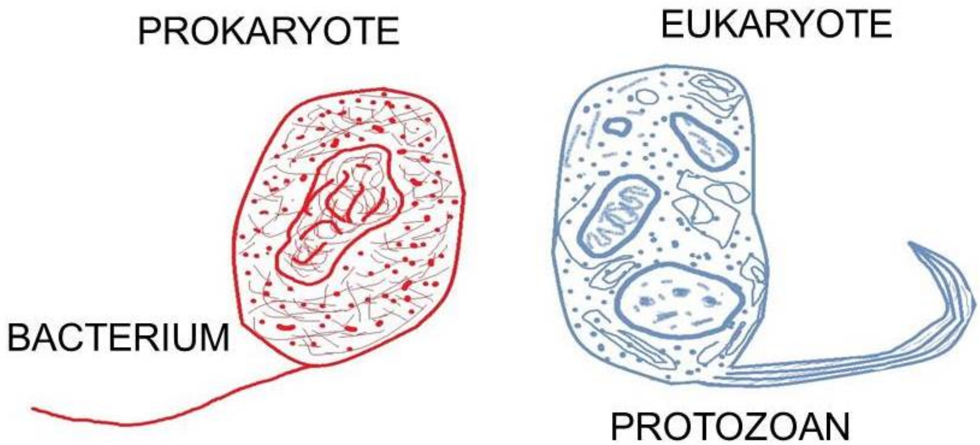
ASCOMYCOTA FUNGI EXAMPLE

The largest number of lichenized fungi occur in the Ascomycota, with about 40% of species forming such an association. Some of these lichenized fungi occur in orders with nonlichenized fungi that live as saprotrophs or plant parasites (for example, the Leotiales, Dothideales, and Pezizales).

Other lichen fungi occur in only five orders in which all members are engaged in this habit (Orders Graphidales, Gyalectales, Peltigerales, Pertusariales, and Teleoschistales). Lichenized and nonlichenized fungi can even be found in the same genus or species. Overall, about 98% of lichens have an ascomycetous mycobiont. Next to the Ascomycota, the largest number of lichenized fungi occur in the unassigned fungi imperfecti.

Comparatively few Basidiomycetes are lichenized, but these include agarics, such as species of Lichenomphalia, clavarioid fungi, such as species of Multiclavula, and corticioid fungi, such as species of Dictyonema. The autotrophic symbionts occurring in lichens are simple, photosynthetic organisms commonly and traditionally known as algae. These symbionts include both prokaryotic and eukaryotic organisms.

Approximately 100 species of photosynthetic partners from 40 genera and five distinct classes (prokaryotic: Cyanphyceae; eukaryotic: Tribophyceae, Phaephyceae, Chlorophyceae, and Pleurostrophyceae) have been found to associate with the lichen-forming fungi.



PROCARYOTES ARE SIMPLER THAN EUCARYOTES

The prokaryotes belong to the Cyanobacteria, whose representatives are often called bluegreen algae. The bluegreen algae occur as symbionts in about 8% of the known lichens. The most commonly occurring genus is Nostoc. The majority of the lichens contain eukaryotic autotrophs belonging to the Chlorophyta (green algae) or to the Xanthophyta (yellow-green algae). About 90% of all known lichens have a green algae as a symbiont, and among these, Trebouxia is the most common genus, occurring in about 40% of all lichens. The second most commonly represented green algae genus is Trentepohlia. Overall, about 100 species are known to occur as autotrophs in lichens. All the algae are probably able to exist independently in nature as well as in the lichen.

A particular fungus species and algal species are not necessarily always associated together in a lichen. One fungus, for example, can form lichens with a variety of different algae. The thalli produced by a given fungal symbiont with its differing partners will be similar, and the secondary metabolites identical, indicating that the fungus has the dominant role in determining the morphology of the lichen. Further, the same algal species can occur in association with different fungal partners. Lichens are known in which there is one fungus associated with two or even three algal species. Rarely, the reverse can occur, and two or more fungal species can interact to form the same lichen. Both the lichen and the fungus partner bear the same scientific name, and the lichens are being integrated into the classification schemes for fungi. The alga bears its own scientific name, which bears no relationship to that of the lichen or fungi.

Wood Fungi Examples

Wood fungi above and below, Shelf fungi or Bracket Fungi

Wood lichen, similar to Spanish Moss above and below, Shelf fungi or Bracket Fungi

Wood Rot Control Measures

Soft rot fungi are heartier than white and brown varieties and can spread more easily in conditions that are too hot, cold, or wet for their counterparts. They are less aggressive in their decomposition, but more hearty. Like their namesake, telltale softness in wooden structures is a sign of their presence.

White rot fungi causes rotted wood to feel moist and appear whitish-yellow in coloring. A few examples of fungi that cause white rot include the honey mushroom, oyster mushrooms, tinder fungus, and artist's conch.

Brown rot is similar to white rot in many ways, except that the process leaves behind darker colored decay that cracks, shrinks, and generally warps the wood it has gotten in contact with. Well known brown rot fungi include the mine fungus, cellar fungus, and sulfur shelf.

Wood rot is dangerous because of how quickly it can consume the bones of a building once it has come into contact with them, destroying the strength of lumber and in turn causing cracks, leaks, and overall structural damage. The moisture that comes with wood rot is also a big draw for pest animals or insects that can move in, making your single problem into multiple problems.

Prevention

1. If the decay hazard is high, select the heartwood of decay-resistant species or use wood properly treated with a good preservative. Conifers from which decay-resistant lumber is produced include Pacific yew, juniper, redwood, bald cypress, and western red cedar. Durable hardwood species include osage orange, black locust, red mulberry, catalpa and black walnut.
2. Build on a well-drained site. Use proper grading to prevent water from seeping under the house. Install effective drain tile, roof overhang, gutters, and downspouts. Place no untreated wood within 18 inches of the ground.
3. Provide adequate cross ventilation beneath buildings to eliminate dead air pockets. Install two square feet of opening for 25 linear feet of wall. Dense bushes or other plants should not be placed in front of these ventilators.
4. Install a vapor barrier on the soil surface to cause soil moisture to condense on the barrier and return to the soil rather than condensing on the floor and above joists. Satisfactory barriers can be made by covering the soil with asphalt roofing paper or polyethylene sheets.

Repair of Decayed Buildings

First determine the source of moisture and remove it. If adequate ventilation and soil drainage are provided and all contacts of untreated wood with the soil or moist concrete or masonry are broken, decayed wood will dry out and further decay will be stopped. When making replacements, cut out at least one foot beyond the rotten area. Avoid placing new lumber in contact with old, decayed wood. Replacement lumber should be treated before installation. Remodel to provide more ventilation and better design rather than simply replacing decayed lumber.

Chemical Treatment
Disodium octaborate tetrahydrate or sodium borate with brand names of Bora-Care®, Guardian®, Jecta®, Shell-Guard®, Tim-bor® and Impel® rods are labeled for protection and treatment of wood and wood-foam composite structural components against decay fungi and wood destroying insects.

For example, remedial control of organisms attacking wood, apply a 15 percent or two applications of 10 percent aqueous solution of Tim-bor® 98 percent (1-lb/gallon solution) or Bora-Care® diluted 1:1 or 2:1 with water. The solution may be applied by brush or spray until the surface is thoroughly wetted (approximately five gallons per 1,000 square foot). An application may also be made by drilling, and then injecting the solution directly into the infested area. Inject a sufficient amount of solution to cause runoff from exit holes drilled into the infested wood.

Also one may apply **Tim-bor®** dust to infested wood by drill and injection directly into galleries (a passage or tunnel made in wood by an insect); or dust wood surfaces and wall voids at a rate of two to three pounds per 100 square foot. Tim-bor® is applied by licensed pesticide applicators or pest control operators. For product information, contact U.S. Borax Corporation, 1(800)9-TIM-BOR.

Shell-Guard® and Guardian® are labeled for protection and treatment against decay fungi and wood destroying insects. These two products are formulated with propylene and polyethylene glycols, making them doubly safe to use. Since these products are borate based, the protection is permanent after application.

Guardian® is the highest concentration available in a formulated borate product. It can be directly injected into holes to provide fast penetration into problem areas. Rapid diffusion is assured by the formulated carriers. Holes can be sealed to match the original finish of the wood.

Shellguard® is a liquid, labeled for topical application. Because of its concentration, multiple applications are unnecessary. Like Guardian®, one application is all that is required. Both of these products are labeled for home use, and can be easily and safely applied by the homeowner. (For further information on either Shellguard® or Guardian®, contact Perma-Chink Systems at 1-(800)-548-1231 or 1-(800)-548-3554.

Another formulation known as Impel rods is molded from highly concentrated water-diffusible boron into a solid tube resembling glass in appearance. These rods are internationally recognized as an effective preservative and deterrent to rot. Unlike fumigants and sprayed or brushed on preservatives, Impel Rods are inserted through small holes strategically drilled into wood where signs of rot are evident or in high-risk, rot-prone areas. The holes are sealed and may be finished to match the wood's original appearance. Rods are odorless, EPA registered, do not stain wood and are available in various sizes to fit virtually any application from heavy timbers and posts to millwork and door frames. However, where damage threatens the structure integrity of wood, the wood should be replaced.

Whenever the moisture content of wood is high enough to sustain rot, Impel Rods® slowly dissolve, spreading the active borate protection into the area surrounding the rod. When the wood dries, the preservative remains in the wood. As the cycle is repeated, the preservative builds up as an effective deterrent to rot.

(For further information, contact Nisus Corporation, 215 Dunavant Drive, Rockford, TN 37853 Telephone: 1-(800)-264-0870, Fax: (423)-577-5825.

Pentachlorophenol

In the past, pentachlorophenol (Penta®) and copper naphthenate was used as a stop gap measure. (These chemicals had offensive smells and were not environmentally safe.) Now with a growing environmental concern, various formulations of sodium borate do not pose a serious threat. A key valve is the absence of offensive smells sometimes associated with other common treatment methods. Also, existing moisture in the wood enhances chemical penetration.

Treatment of Wood Infested by Decay and/or Wood

Boracare application methods for treating beetle and decay infestations are similar. Treat the infested and surrounding area with Boracare according to label directions. When practical, infect diluted Boracare solution into beetle emergence holes and galleries. It is important to treat the entire infested wooden member. If only a small portion of a wood member is treated there is a possibility that the amount of active ingredient in the treated area may eventually diffuse to a level below that needed for effective control.

Since wood can contain active beetle larvae or fungal spores with no surface evidence of infestation, the best method of control is to treat the entire area where an infestation has been found. This would include all of the wood in a crawl space, wall or attic showing any signs of damage.

Infested wood flooring can be treated with Bora-Care by spray or brush application. It will be necessary to remove any existing finish by sanding or stripping prior to application. Refer to the Boracare label section on treating flooring for application rates and methods.

When controlling decay fungi, treatment with Boracare should not be considered as a replacement for moisture control. Leaky plumbing and drain spouts should always be repaired in addition to treatment. Wet crawl spaces should be vented and plastic sheeting installed. Structural wood members that are no longer sound must be replaced. Although Bora-Care will kill beetle larvae and decay fungi, it will not add strength to damaged wood.

Preventative Treatments With BORACARE

Un-infested wood may be protected from insects and decay with a Boracare treatment. After treatment, exterior treated wood surfaces should be coated with a water repellent finish such as paint or stain. It is important to allow the Boracare to completely dry before applying any protective topcoat.

Treating Wood In Contact With the Ground For Decay

Bora-Care may be applied to wood in contact with the ground or soil. However, water passing through the wood will limit the life of a BoraCare treatment. A better approach is to inject Jecta Diffusible Boracide (Jecta Gel) into the high risk area. Jecta will last longer than Boracare in this situation. In addition to eliminating and protecting the wood from decay, Jecta is also effective against subterranean termites. However, Jecta should not be used for treating wood boring beetle infestations. Refer to the Jecta Diffusible Boracide specimen label for complete application instructions.

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Elimination and Prevention of Decay Fungi

Some type of moisture control should be an integral part of any program designed for the elimination of decay fungi. The following rules are a good place to start:
1. No wood should ever be in contact with the ground. Wood posts, piers, supports, etc. should always rest on concrete footers raised above the level of the surrounding soil.
2. Basements should be waterproof and equipped with a floor drain. If the relative humidity in the basement exceeds 50%, a dehumidifier should be installed.
3. Crawlspaces should be adequately ventilated with at least one square foot of free vent area for every 500 square feet of crawl space floor area along with a moisture barrier covering at least 80% of floor. One vent should be placed within three feet of each corner to prevent "dead air" spaces and in high humidity environments additional vents should be considered.
4. Plumbing leaks should be repaired as soon as they are noticed.
5. Rain gutters need to be clear of debris and roof leaks fixed.
6. Exterior wood should be coated with a water repellent paint or stain.

Chemical Control Methods
Both Armor-Guard® and Shell-Guard® are labeled for treating wood for decay fungi including brown and white rot. Most decay fungi are quite sensitive to borates, so for most situations Armor-Guard will suffice for treating an area. However, if there are fruiting bodies present or hair-like growth on the surface, Shell-Guard should be used to treat these heavily infested zones.

If you are working in a crawl space, be sure to remove any insulation that may be present between the floor joists before you begin and check the entire area with a moisture meter. If there are any sections of wood where the moisture content is 20% or above, a preventative treatment with Armor-Guard is recommended.

Follow the label directions and spray the wood to the point of run-off. After treatment, make sure all crawl space vents are open and, if necessary, install temporary fans to help dry the wood before replacing the insulation. We also recommend that moisture control be incorporated into any program involving infestations related to high moisture conditions.

Within a few days after a treatment has been completed the fungi will begin to die and dry up. Occasionally the dead fungi will emit an unpleasant odor as it decomposes. This odor will only last a couple of days and may be minimized with the circulation of fresh air into the treated area.

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Mold Sub-Section

Many people confuse the presence of molds with decay fungi. Although molds are a form of fungi, they typically grow on the surface of wood and generally do not weaken the wood's strength. However, the presence of mold is a good indication that the moisture level in the wood is high enough to also support the growth of decay fungi. Moisture control methods used to prevent decay fungi will also remove conditions favorable for mold growth.

Fungi Kingdom
Molds are part of the fungi kingdom. Fungi are a diverse group of organisms within a wide range of species that include mushrooms, bracket fungi, molds and mildew. Distinguishing features of fungi are the need to extract their food from the organic materials they grow on and the ability to reproduce by way of minute spores. Fungi are a part of nature's recycling system and play an important role in breaking down materials such as plants, leaves, wood and other natural matter.

Mold is the common name for many types of micro fungi. In order to grow, molds require food, suitable temperature (ideally between 70 and 85 degrees Fahrenheit), oxygen and moisture (Zabel, 1992). When these conditions are met, mold will grow and reproduce by creating spores that are released into the air.

Molds are very adaptable and can grow even on damp inorganic materials such as glass, metal, concrete or painted surfaces if a microscopic layer of organic nutrients is available. Such nutrients can be found on household dust and soil particles.

Conservatively, more than 100,000 species of mold exist in the world. At least 1,000 mold species are common in the U.S. (Hawksworth, 1999). It is estimated that molds and other fungi make up some 25 percent of the earth's biomass.

Most mold spores land on places unsuitable for growth and eventually die. A select few land on surfaces containing nutrients and where the moisture, oxygen and temperature conditions are right for growth.

Mold and mold spores are everywhere around us and have always been a part of our environment. The air we breathe is a virtual jungle of fungal spores. We routinely encounter mold spores as part of everyday life both indoors and outdoors. Spore levels may vary seasonally, but some spores are always present.

Biological Material
Wood is a biological material consisting primarily of cellulose, lignin and hemicellulose. These three structural polymers make up 90 to 99 percent of the wood mass and give wood its unique properties that make it an excellent structural material (Panshin, 1980).

Wood also contains a variety of other materials, including sugars, starches, proteins, lipids and fatty acids. These materials are present in the storage tissues of the living tree and are essential for a variety of functions. Even after a tree is harvested, these materials remain in the wood and can provide the initial food source for mold fungi.

Mold fungi are rarely present inside a living tree because the bark provides an excellent barrier against fungal and insect attack. Once the tree is harvested, these protective effects decline and the many spores present in the air can settle on the surface and colonize the wood. Also, the food sources for mold -- the stored sugars, starches and other compounds -- are exposed when logs are processed into lumber.

WOOD MOLD ON PROCESSED LUMBER
MOLDS AND STAINS COME IN MANY DIFFERENT COLORS
THIS ONE ABOVE IS WHITE

What Types of Molds are Found on Wood?

Under the proper conditions, wood may be colonized by a variety of fungi (Davidson, 1935; Dowding, 1970; Kaarik, 1980). A recent study at Oregon State University revealed that Douglas fir sapwood was colonized by over 45 species of fungi within six weeks after sawing (Kang, 2000). Most of these fungi are common to many other materials, while a few were specialized and only grow on wood. Molds and stain fungi are the most rapid colonizers of freshly exposed wood. Both fungi discolor the wood and are almost indistinguishable from each other to the naked eye. Molds are typically characterized as fungi that discolor the wood surface through production of pigmented spores that can be yellow, green, orange, black and an array of other colors. The discoloration seen with molds is usually confined to the wood surface.

Stain Fungi

Stain fungi discolor the wood more deeply and are not as easily removed. These fungi may produce some discoloration as they grow on the wood surface, but the primary changes occur as they grow deeper into the wood. Stain fungi darken as they age.

This darkening creates what is called "blue stain" in the wood (Zink, 1988). Stained wood can experience minor losses in physical properties, but, like molds, the primary changes are in color and the increased ability to absorb liquids (Lindgren, 1952).

Redbay stem with vascular staining from R. lauricola. The fungus chokes off the movement of water. Affected trees wilt and die in weeks or months.

Decay Fungi

Decay fungi may also grow when wood products are exposed to chronic moisture. Decay fungi attack beyond the surface of the wood into the structural polymers of the fiber, reducing its strength. Decayed wood may be discolored, but spores of the decay fungus are not typically found on the surface. Spores of most species are produced on more complex fruiting structures that can produce billions of spores.

Generally, decay fungi invade wood in structures after prolonged exposure to moisture, such as what occurs with plumbing leaks or seeping from outdoor water sources. Many of the molds and other fungi that grow on wood are found on almost any material containing sugars or starches, including plant leaves, bread and other foods. They can grow on a microscopically thin layer of organic material, even forming on common household dust. These fungi have evolved to rapidly colonize a substrate and utilize the stored sugars as quickly as possible, but they lack the ability to cause significant effects on the wood structure. The most common effect of mold attack on wood is an increase in permeability, which can lead to an increase in moisture or paint uptake (Lindgren, 1952).

How are Molds Identified?

Mycology is the scientific study of fungi. Proper identification of molds requires that the person examining the fungi have extensive professional training in mycology. Although some species produce distinctive structures or colors, it is nearly impossible to identify the fungi present on wood with the naked eye. The identification of fungi from a sample using a microscope can take a few days or several weeks, depending on the species.

Most mold and stain fungi are identified by the spores they produce and the structures on which they are produced. Samples can be taken by smoothing a piece of clear tape on the wood surface, then mounting the tape on a microscope slide. Another approach is to cut small pieces from the wood surface, then place these on a nutrient media. Fungi growing from the wood onto the media are then examined under a microscope for spores and other key identifying features.

It is important to note that finding mold does not provide information about the possible exposure to mold, or the risk of health effects from mold. The airborne mold spore concentration, or possible exposure to mold, cannot be calculated from the types and quantity of molds found on surfaces.

In addition, many homeowners ask to have molds identified to species. In most cases, this is unnecessary and costly. Molds are a moisture indicator and should be dealt with as such.

Eliminating the moisture source and cleaning the affected surfaces generally negates the need for identification. So-called “mold test kits” should be used with caution and the results interpreted carefully since sampling accuracy is an important aspect in using these kits.

A visual inspection is usually the most effective method for distinguishing clean and moldy environments. In the absence of visible mold growth, sometimes the air is sampled to estimate the number of airborne mold spores.

How Can Mold on Lumber be Prevented?
All fungi have four basic requirements for growth: suitable temperature, oxygen, food and moisture. Eliminating one of these required elements can prevent fungal growth (Scheffer, 1940; 1973). Mold fungi have fairly broad temperature requirements but most grow best at temperatures between 70 and 85 degrees Fahrenheit. Most fungi require oxygen to function. In fact, one method for preventing stain and mold in wood is to submerge it in fresh water, which fills the wood cells with water and limits the availability of oxygen. Lumber and wood product mills often utilize this method by spraying log decks with water or storing logs in ponds at the plant.

While controlling temperature or oxygen is generally not practical for wood products, it is possible to remove moisture as quickly as possible during manufacturing. Reducing the moisture content of lumber to less than 20 percent will significantly decrease the opportunities for mold to form on the wood. This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them.

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Drying lumber reduces the likelihood of mold formation. But it does not guarantee the wood will remain free of mold. Lumber that is exposed to moisture after it has been dried will support mold growth.

Dry lumber can become wet through direct sources, such as rainfall or condensation. Even dry lumber contains some moisture. So, wet pieces inside wrapped bundles of lumber could create conditions for mold growth. Exposing the bundle to direct sunlight, for example, could heat the lumber and the wrapping may trap the evaporating moisture. This trapped moisture can be sufficient to support mold growth.

Each year, billions of board feet of lumber are sold as un-seasoned, or green products and are allowed to dry naturally, usually during the framing stages of building a house. Many mills reduce the risk of mold and stain on green lumber by applying anti-stain, or sap stain treatments, which are thin coatings of fungicides on the wood surface. These fungicides are applied by dipping entire bundles of lumber into a treatment solution or by spraying all four surfaces of individual boards (Scheffer, 1940).

These chemicals are designed to provide a microscopic barrier against fungal attack that lasts for three to six months, depending on the chemical, the concentration used, the wood species and the climatic conditions. The chemicals used for preventing mold and stain are usually very mild and include many used on food crops as well as in shampoos and paints. They are not designed for long-term protection of the wood.

When Should Mold be Removed?
Visible mold growing on surfaces where people may come in contact with it should be cleaned and removed. The decision to remove mold from enclosed cavities must be made after considering how much mold is likely to be present and how likely it is to be opened or disturbed.

In some cases, wood can simply be treated for mold growth with a bleach solution, then dried and sealed. Where mold is present in existing structures, there are often reasons for opening walls and removing building parts that are unrelated to mold growth (such as for repairing warped and water-damaged floors or walls). In buildings where mold removal from enclosed cavities is not desirable or feasible, sampling can be conducted to monitor the level of mold spores in the occupied spaces.

The process of removing mold from enclosed spaces could increase exposure to spores in the short term. High indoor mold spore levels are sometimes found when walls and floors containing mold are opened or disturbed, and when visible mold growth is present on exposed surfaces.

Can I Clean the Mold from the Wood?
The decision to clean mold from lumber depends on the amount of mold present and how likely it is to be disturbed. In nearly all cases, mold cleaning should be undertaken only after any moisture problems are resolved. For any mold clean up that may generate large amounts of dust, basic personal protection equipment such as rubber gloves, eye protection and a high-quality pollen or dust mask should be worn. Clean-up of small spots or areas of mold generally does not require any special protective equipment.

There are a number of products on the market, from commercial mildewcides to common bleach, which are promoted for removing mold from wood. However, the U.S. Environmental Protection Agency suggests using mild detergent and water for most mold clean up. For cleaning wood surfaces, the EPA recommends wet vacuuming the area, wiping or scrubbing the mold with detergent and water and, after drying, vacuuming with a high-efficiency particulate air (HEPA) vacuum (EPA, 2001).

The molds seen on lumber are largely a collection of fungal spores on the surface of the wood. As such, wet wiping or scrubbing the lumber will remove the mold.

Simply wiping the wood, however, can release those spores into the surrounding air. A better approach is to gently spray or wet down the mold prior to removal. Once the mold has been wetted, it can be removed by wet-wiping the surfaces with a water and detergent solution, scrubbing if necessary.

If commercial products are used for cleaning mold, be sure to follow the manufacturer's instructions for use. Common bleach also can be used, particularly to clean the discoloration caused by mold fungi. The U.S. Centers for Disease Control (CDC) recommends using a solution of 10 parts water to one part chlorine bleach to clean mold from surfaces (CDC, 2000b). When using bleach and other cleaning chemicals indoors, make sure there is adequate ventilation and wear personal protection equipment outlined previously. Never mix bleach with ammonia.

Removing small amounts of mold from wood is relatively straightforward. Mold removal becomes more complex when there are heavy amounts of growth on a majority of the lumber or if the building has been in service for some time and the mold originated from leaks into the building cavity. In these instances, the mold clean up should be done by a professional cleaning and restoration company.

Once I Clean the Mold, Can it Come Back?
Mold spores are present on surfaces in all homes, so cleaning will not prevent re-growth of mold. Even if a building is stripped of all components and every spore is killed or removed, normal background mold spores from outdoors or on replacement parts have the potential to grow (Taylor, 2004). The most important objective in any mold removal is to remove or repair any sources of moisture.

Should the wood framing in a house become wet, through leaks or flooding, it is imperative that the area be dried as soon as possible. In many climates, this drying will occur naturally once any standing water is removed. In other climates where the relative humidity is higher, it may be necessary to bring in portable fans to increase airflow or to use the existing heating system or portable electric heaters to encourage faster drying.

Are there Mold Regulations?
In the U.S., there are currently no regulations or exposure limits for molds or mycotoxins. This is true for homes, occupational settings, schools, stores and other public buildings. In the occupational setting, the general duty clause may apply to mold exposures. This is the rule that requires employers to provide workers with a safe and healthy work environment. The Occupational Safety and Health Administration (OSHA) should be consulted for specific information on work-related mold questions.

Because there are no exposure limits for molds, there are no "benchmarks" with which to compare exposure measurements. Typically, measured indoor airborne mold levels are compared to outdoor concentrations. Differences between the types and numbers of molds indoors vs. outdoors can provide clues as to whether the exposures indoors are above the background level and whether there is a source of mold inside the building. However, these data usually cannot be used to determine if exposure levels are safe. In most cases, air sampling for mold is not needed to assess or remediate a mold problem.

Mold Summary
Molds play an important role in nature by breaking down organic materials. We routinely encounter mold spores as part of everyday life, in both outdoor and indoor environments. In most cases, the body's immune and respiratory systems normally provide defense mechanisms that protect it from health effects of regular exposure to molds.

Inhalation of molds can result in a range of health effects in some circumstances. Infections are possible in immune-compromised people, although there are no reports of this occurring from mold growth in a residence. Allergic responses to molds include hay fever and asthma, and many people with allergies are also allergic to mold. The amount of mold that must be inhaled to cause an allergic response is unknown. Toxic effects from inhalation of mold may occur in situations where there are prolonged exposures to exceedingly high airborne mold concentrations, such as in an agricultural setting. These high concentrations have not been reported to occur in residences with mold enclosed in finished walls.

Lumber is just one of thousands of materials that can be a potential growth substrate for mold under the proper conditions. In a vast majority of cases, mold problems in homes are related to flooding or water leaks that affect many materials in the structure, including lumber.

Moisture is essential for mold growth and controlling moisture offers the best protection against mold. While all wood contains moisture, mold growth is not supported on wood dried to below 20 percent moisture content. Lumber used in construction will typically dry to below 20 percent moisture content before the structure is enclosed. Drying lumber does not guarantee the wood will remain free of mold. If lumber is exposed to moisture after it has dried, it can provide a surface for mold to grow.

2017 Changes to EPA's Farm Worker Protection Standard

In late 2015 the Environmental Protection Agency issued the long awaited revision to the Worker Protection Standard (WPS). 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 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.

Mold Human Health Problems

It is critical to identify and eliminate mold as soon as it begins to develop. Mold can be highly toxic and can have a long-lasting effect on human health depending on the species and the extent of exposure. Children, seniors, pregnant women and people with pre-existing health conditions are particularly vulnerable to the effects of mold. Mold is such a severe health issue that organizations like the Institute of Medicine (IOM), the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) have all researched and published findings on the links between this toxic substance and different illnesses and health conditions.

Here are some of the important health effects of mold exposure:

- **Mold Sensitivity:** Some people are particularly sensitive to mold, while others can develop a sensitivity over time due to prolonged exposure. Other people may have more sensitive mold allergies and can be severely affected by it. Mold sensitivity includes symptoms like:
    - Chest and nasal congestion
    - Coughing, sneezing and wheezing
    - Sore throat
    - Watering, dry or sore eyes
    - Skin irritation
    - Headaches
- **Mold-Related Infections:** People with compromised immune systems or pre-existing lung conditions such as Chronic Obstructive Pulmonary Disorder (COPD) are much more susceptible to mold's health hazards. In fact, people with these types of conditions can potentially develop infections in their lungs due to mold exposure.
- **Respiratory Conditions:** In addition to mold being bad for people with existing lung illnesses, mold exposure can also potentially cause respiratory conditions in otherwise healthy people. This includes symptoms such as upper respiratory tract problems, coughing and wheezing and shortness of breath. It is also linked to developing respiratory illnesses like asthma in certain people who are likely more susceptible. This is particularly concerning for healthy children who may go on to develop asthma or other types of respiratory illnesses. For those who currently suffer from asthma, mold exposure can intensify symptoms and cause asthma attacks.
- **Severe and Chronic Conditions:** Certain types of mold produce mycotoxins, a dangerous toxic by-product that can be absorbed by the skin, airways and intestinal lining. Prolonged exposure to mycotoxins can lead to severe and even deadly conditions. Some of the potentially dangerous symptoms of mycotoxigenic exposure include:
    - Pulmonary fibrosis (scarring in the lungs)
    - Cancer
    - Pulmonary bleeding
    - Immune and blood disorders
    - Liver and kidney conditions
    - Neurotoxicity (toxic nervous system)
    - Pregnancy conditions
    - Digestive and heart conditions

Mold Remediation Process

While it is important to know when to call in a professional mold remediation team, there are a couple things you can do yourself to get rid of mold if it's in a small area:

1. **Locate the Mold:** Remember that mold spreads, so be sure to check all rooms in your home including, especially dark and damp areas like the basement. Be sure to also check under the carpeting, flooring and behind wallpaper or drywall.
2. **Get Rid of Moldy Materials:** Materials that cannot be cleaned and salvaged need to be disposed of. This includes wood, drywall, carpets or anything else that is growing mold. Use safety gear such as gloves, masks, and goggles before handling moldy items.

If the mold infestation is on a larger scale, a professional mold remediation team will likely do the following, in addition to getting rid of moldy items:

1. **Use Commercial Equipment to Dry Out the Affected Area:** It's important to get your home dried out as much as possible since mold thrives in wet and humid environments. Professionals will use air movers, commercial dehumidifiers and air scrubbers that work together to eliminate moisture and dry out the air and surfaces. They'll also wear safety gear like gloves, a mask and eye goggles.
2. **Prepare the Room to Contain the Mold Problem:** Mold spores can instantly become airborne. To avoid this, professionals will seal off the affected area before they get to work. They'll use tape and plastic sheets to seal off doorways and vents.
3. **Establish Negative Air Pressure:** Establishing negative airflow in the sealed room using an air mover ensures airflows in but not out. Once the area has been sealed using plastic sheets and tape, professionals can poke a small hole in the plastic and insert an air mover duct attachment through the hole and seal it with duct tape. This negative air pressure further prevents mold spores from escaping into the rest of your home.
4. **Use Fungicide on Remaining Materials:** If there are any materials that can be salvaged and will remain in the room then it is important to thoroughly clean them. A fungicide product can ensure all the mold spores are removed and that there is no opportunity for a recurrent infestation. Any buildings materials that cannot be cleaned or removed such as porous surfaces should have a fungicide applied to them.
5. **Finish Repairing the Room:** Once the moldy materials have been removed and the area has been thoroughly cleaned, any necessary repairs from the water can mold damage can be completed. This may include flooring, carpeting or drywall repairs.

Harmful molds can be any of the following classifications:

- **Allergenic:** Molds that cause and produce allergies and allergic reactions such as asthma attacks.
- **Pathogenic:** Molds that cause health problems in those suffering from an acute illness.
- **Toxigenic:** Molds that produce toxic substances that can lead to dangerous or even deadly health conditions. This is sometimes referred to as "toxic mold."

Internal Wood Fumigant Treatments Sub-Section

Fungicides

Fungicides are biocidal chemical compounds or biological organisms used to kill parasitic fungi or their spores. A fungistatic inhibits their growth. Fungi can cause serious damage in agriculture, resulting in critical losses of yield, quality, and profit. Fungicides are used both in agriculture and to fight fungal infections in animals. Chemicals used to control oomycetes, which are not fungi, are also referred to as fungicides, as oomycetes use the same mechanisms as fungi to infect plant.

Multiple organisms (viruses, nematodes, fungi, and bacteria) can cause plant disease. Preventing and managing disease is best accomplished by a combination of practices, known as Integrated pest management or IPM. Management practices include matching the plant with the site, selecting disease-resistant varieties, plant care that prevents stress (irrigation, mulch, fertilization as needed etc.) as well as fungicide use when warranted.

Fungicides are pesticides that prevent, kill, mitigate or inhibit the growth of fungi on plants, but they are not effective against bacteria, nematodes, or viral diseases. Fungicides can be classified based on:

Mobility in the plant: Contact vs. mobile (types of systemics). Contact fungicides (AKA protectants) are not absorbed by the plant and stick to plant surfaces. They provide a protective barrier that prevents the fungus from entering and damaging plant tissues. Systemic products (also known as penetrants), are absorbed by the plant and can move from the site of application to other parts of the plant. Movement in the plant varies by fungicide, form moving to old and new tissues (amphymobile or true systemic), new growth (acropetally or xylem mobile), moving from the top to the bottom of the leaf surface (translaminar).

Preventive vs. curative: Preventive fungicides work by preventing the fungus from getting into the plant. The preventive fungicide must come into direct contact with the fungus, and they have to be re-applied to new plant tissues (as leaves or needles expand in the spring) or if the product washes off. Curative fungicides affect the fungus after infection. This means they can stop the disease after the infection has started or after first symptoms are observed. Fungicides that can move in the plant can be both preventative and curative.

Mode of action: This refers to how the fungicide affects the fungus. Fungicides may work by damaging the cell membrane of the fungus, inhibiting an important process that the fungi, pinpointing a single or multiple processes in the fungus. It's important to incorporate different modes of action by mixture or by alternating products to maintain effectiveness and prevent fungicide resistance. Stay tuned for our article "what is fungicide resistance?".

Rules of Thumb Fungicide Use
For efficient and safe fungicide use, certain rules have to be followed:
The problem has to be diagnosed correctly: Before applying a fungicide make sure that you know the cause of the disease (is it a disease? If so what is causing it? Fungi? which one?) and when (spring, fall etc.) and how often to apply the fungicide.

The timing of the fungicide application can enhance the effectiveness of the product and prevent additional sprays. When ready to use the recommend fungicide for the particular problem your plant is facing, read the label and follow instructions. This will not only protect your plant, but it will also protect your health and the environment. Remember always to apply fungicides using the appropriate equipment at the recommended application rate.

Fungicide labels provide information on recommended use, ingredients, mode of action, and formulation of the product.

Remember that the best management strategy against plant diseases is by promoting plant health in the first place. Before planting, make sure that soil, water, and light conditions are ideal for your plant. Once the plants have been established, make sure to use the appropriate sanitation, fertilization, and pruning practices to enhance plant health.

Wood preservative products are those that claim to control wood degradation problems due to fungal rot or decay, sapstain, molds, or wood-destroying insects. Both the treatment process and the use of treated-products can result in exposure to pesticides for both people and the environment. Most of the treatment processes and uses of treated products occur outdoors. There are wood preservatives that support a tolerance for indirect food-contact uses such as wooden crates, pallets, and stakes used to store or grow raw agriculture commodities.

Generally, freshly cut logs or lumber are treated and then manufactured into products such as:

- Seasoned building materials.
- Utility poles, fence posts and rails.
- Structural members.
- Structures and dwellings.
- Transportation vehicles (truck beds and support structures).
- Crop containers.
- Lawn furniture and decks.
- Playground equipment.
- Garden/landscape timbers.
- Log homes.

Fungicides that can be taken up by the plant are absorbed. Fungicides that adhere in an extremely thin layer to plant surfaces are adsorbed. Because fungicides are either adsorbed or absorbed, they have two basic forms of mobility: contact and penetrant. Regardless of the type of mobility that a fungicide possesses, no fungicide is effective after the development of visible disease symptoms. For that reason, timely fungicide application before establishment of the disease is important for optimal disease management. Contact Fungicides Contact fungicides are adsorbed.

They are susceptible to being washed away by rain or irrigation, and most (but not all) do not protect parts that grow and develop after the product is applied. Most older, multi-site fungicides (such as captan, chlorothalonil, mancozeb, and copper) are contact fungicides. Contact fungicides:

- Must be applied before spores land on and infect leaves.
- Prevent spore germination, so they are preventative treatments.
- Have no effect once the infection is established.

Penetrant Fungicides
Penetrant fungicides are absorbed, so they move into plant tissues, and penetrate beyond the cuticle and into the treated leaf tissue itself. There are various kinds of penetrants, characterized by their ability to spread when absorbed by the plant.

Localized penetrants remain in the area of initial plant contact and undergo very little movement within the plant (a process called translocation).

Fumigants
As with diffusibles, fumigants are applied in liquid or solid form in predrilled holes. However, they then volatilize into a gas that moves through the wood. To be most effective, a fumigant should be applied at locations where it will not readily volatilize out of the wood to the atmosphere. When fumigants are applied, the timbers should be inspected thoroughly to determine an optimal drilling pattern that avoids metal fasteners, seasoning checks, and severely rotted wood. In vertical members such as piles, holes to receive liquid fumigant should be drilled at a steep angle (45° to 60°) downward toward the center of the member, avoiding seasoning checks. The holes should be no more than 1.2 m (4 ft) apart and arranged in a spiral pattern.

With horizontal timbers, the holes can be drilled straight down or slanted. As a rule, the holes should be extended to within about 5 cm (2 in.) of the bottom of the timber. If strength is not jeopardized, holes can be drilled in a cluster or in pairs to accommodate the required amount of preservative. If large seasoning checks are present, the holes should be drilled on each side of the member to provide better distribution.

As soon as the fumigant is injected, the hole should be plugged with a tight-fitting treated wood dowel or removable plastic plug. For liquid fumigants, sufficient room must remain in the treating hole so the plug can be driven without displacing the chemical out of the hole. The amount of fumigant needed and the size and number of treating holes required depends upon the timber size. Fumigants will eventually diffuse out of the wood, allowing decay fungi to recolonize. Fortunately, additional fumigant can be applied to the same treatment hole. Fumigant treatments are generally more toxic and more difficult to handle than are diffusible treatments. Some are classified as restricted-use pesticides by the U.S. EPA.

One of the oldest and most effective fumigants is chloropicrin (trichloronitromethane). Chloropicrin is a liquid and has been found to remain in wood for up to 20 years; however, a 10-year retreatment cycle is recommended, with regular inspection. Chloropicrin is a strong eye irritant and has high volatility.

Due to chloropicrin's hazardous nature, it should be used in areas away from buildings permanently inhabited by humans or animals. During application, workers must wear protective gear, including a full face respirator. Methylisothiocyante (MITC) is the active ingredient in several fumigants, but is also available in a solid-melt form that is 97% actives. The solid-melt MITC is supplied in aluminum tubes. After the treatment hole is drilled the cap is removed from the tube, and the entire tube is placed into the whole.

This formulation provides ease of handling and application to upward drilled sloping treatment holes. Metham sodium (sodium N-methldithiocarbamate) is a widely used liquid fumigant that decomposes in the wood to form the active ingredient MITC.

Granular dazomet (tetrahydro-3, 5-dimethyl-2-H-1,3,5, thiodazine-6-thione) is applied in a solid granular form that decomposes to a MITC content of approximately 45%. Dazomet is easy to handle but slower to decompose and release MITC than the solid-melt MITC or liquid fumigants. Some suppliers recommend the addition of a catalyst such as copper naphthenate to accelerate the breakdown process.

Best Management Practices

The active ingredients of various waterborne wood preservatives (copper, chromium, arsenic, and zinc) are water soluble in the treating solution but resist leaching when placed into the wood. This resistance to leaching is a result of chemical stabilization (or fixation) reactions that render the toxic ingredients insoluble in water. The mechanism and requirements for the stabilization reactions differ, depending on the type of wood preservative.

For each type of preservative, some reactions occur very rapidly during pressure treatment, while others may take days or even weeks, depending on storage and processing after treatment. If the treated wood is placed in service before these fixation reactions have been completed, the initial release of preservative into the environment may be much greater than if the wood has been conditioned properly.

With oil-type preservatives, preservative bleeding or oozing out of the treated wood is a particular concern. This problem may be apparent immediately after treatment. Such members should not be used in bridges over water or other aquatic applications. In other cases, the problem may not become obvious until after the product has been exposed to heating by direct sunlight.

This problem can be minimized by using treatment practices that remove excess preservative from the wood. This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

Best management practice (BMP) standards have been developed to ensure that treated wood is produced in a way that will minimize environmental concerns. The Western Wood Preservers Institute (WWPI) has developed guidelines for treated wood used in aquatic environments. Although these practices have not yet been adopted by the industry in all areas of the United States, purchasers can require that these practices be followed. Commercial wood treatment firms are responsible for meeting conditions that ensure stabilization and minimize bleeding of preservatives, but persons buying treated wood should make sure that the firms have done so.

Consumers can take steps to ensure that wood will be treated according to the BMPs. Proper stabilization may take time, and material should be ordered well before it is needed so that the treater can hold the wood while it stabilizes. If consumers order wood in advance, they may also be able to store it under cover, allowing further drying and fixation. In general, allowing the material to air dry before it is used is a good practice for ensuring fixation, minimizing leaching, and reducing risk to construction personnel. With all preservatives, the wood should be inspected for surface residue, and wood with excessive residue should not be placed in service.

CCA

The risk of chemical exposure from wood treated with CCA is minimized after chemical fixation reactions lock the chemical in the wood. The treating solution contains hexavalent chromium, but the chromium reduces to the less toxic trivalent state within the wood. This process of chromium reduction also is critical in fixing the arsenic and copper in the wood. Wood treated with CCA should not be immersed or exposed to prolonged wetting until the fixation process is complete or nearly complete. The rate of fixation depends on temperature, taking only a few hours at 66 °C (150 °F) but weeks or even months at temperatures below 16 °C (60 °F). Some treatment facilities use kilns, steam, or hot-water baths to accelerate fixation.

The BMP guideline for CCA stipulates that the wood should be air seasoned, kiln dried, steamed, or subjected to a hot-water bath after treatment. It can be evaluated with the AWPA chromotropic acid test to determine whether fixation is complete.

ACZA and ACQ–B

The key to achieving stabilization with ACZA and ACQ–B is to allow ammonia to volatilize. This can be accomplished by air or kiln drying. The BMPs require a minimum of 3 weeks of air drying at temperatures higher than 16 °C (60 °F). Drying time can be reduced to 1 week if the material is conditioned in the treatment cylinder. At lower temperatures, kiln drying or heat is required to complete fixation.

There is no commonly used method to determine the degree of stabilization in wood treated with ACZA or ACQ–B, although wood that has been thoroughly dried is acceptable. If the wood has a strong ammonia odor, fixation is not complete.

ACQ–C, ACQ–D, and Copper Azole

Proper handling and conditioning of the wood after treatment helps minimize leaching and potential environmental impacts for these preservatives. Amine (and ammonia in some cases) keeps copper soluble in these treatment solutions. The mechanism of copper's reaction in the wood is not completely understood but appears to be strongly influenced by time, temperature, and retention levels. As a general rule, wood that has been thoroughly dried after treatment is properly stabilized.

Copper stabilization in the copper azole CA–B formulation is extremely rapid (within 24 h) at the UC3B retention of 1.7 kg m^{-3} (0.10 lb ft^{-3}) but slows considerably at higher retentions unless the material is heated to accelerate fixation.

Pentachlorophenol, Creosote, and Copper Naphthenate

For creosote, the BMPs stipulate use of an expansion bath and final steaming period at the end of the charge.

Expansion Bath—Following the pressure period, the creosote should be heated to a temperature 6 to 12 °C (10 to 20 °F) above the press temperatures for at least 1 h. Creosote should be pumped back to storage and a minimum gauge vacuum of –81 kPa (24 inHg) should be applied for at least 2 h.

Steaming—After the pressure period and once the creosote has been pumped back to the storage tank, a vacuum of not less than –74 kPa (22 inHg) is applied for at least 2 h to recover excess preservative. The vacuum is then released back to atmospheric pressure and the charge is steamed for 2 to 3 h. The maximum temperature during this process should not exceed 116 °C (240 °F). A second vacuum of not less than –74 kPa (22 inHg) is then applied for a minimum of 4 h.

The BMPs for copper naphthenate are similar to those for creosote and pentachlorophenol. The recommended treatment practices for treatment in heavy oil include using an expansion bath, or final steaming, or both, similar to that described for creosote. When No. 2 fuel oil is used as the solvent, the BMPs recommend using a final vacuum for at least 1 h.

Handling and Seasoning of Timber after Treatment
Treated timber should be handled with sufficient care to avoid breaking through the treated shell. The use of pikes, cant hooks, picks, tongs, or other pointed tools that dig deeply into the wood should be prohibited. Handling heavy loads of lumber or sawn timber in rope or cable slings can crush the corners or edges of the outside pieces. Breakage or deep abrasions can also result from throwing or dropping the lumber. If damage results, the exposed areas should be retreated, if possible.

Wood treated with preservative oils should generally be installed as soon as practicable after treatment to minimize lateral movement of the preservative, but sometimes cleanliness of the surface can be improved by exposing the treated wood to the weather for a limited time before installation. Lengthy, unsheltered exterior storage of treated wood before installation should be avoided. Treated wood that must be stored before use should be covered for protection from the sun and weather.

With waterborne preservatives, seasoning after treatment is important for wood that will be used in buildings or other places where shrinkage after placement in the structure would be undesirable. Injecting waterborne preservatives puts large amounts of water into the wood, and considerable shrinkage is to be expected as subsequent seasoning takes place.

Penetration and Retention
Penetration and retention requirements are equally important in determining the quality of preservative treatment. Penetration levels vary widely, even in pressure-treated material. In most species, heartwood is more difficult to penetrate than sapwood. In addition, species differ greatly in the degree to which their heartwood may be penetrated. Incising tends to improve penetration of preservative in many refractory species, but those highly resistant to penetration will not have deep or uniform penetration even when incised. Penetration in unincised heartwood faces of these species may occasionally be as deep as 6 mm (1/4 in.) but is often not more than 1.6 mm (1/16 in.).

Experience has shown that even slight penetration has some value, although deeper penetration is highly desirable to avoid exposing untreated wood when checks occur, particularly for important members that are costly to replace. The heartwood of coastal Douglas-fir, southern pines, and various hardwoods, although resistant, will frequently show transverse penetrations of 6 to 12 mm (1/4 to 1/2 in.) and sometimes considerably more.

Complete penetration of the sapwood should be the goal in all pressure treatments. It can often be accomplished in small-size timbers of various commercial woods, and with skillful treatment, it may often be obtained in piles, ties, and structural timbers.

Practically, however, the operator cannot always ensure complete penetration of sapwood in every piece when treating large pieces of round material with thick sapwood (such as poles and piles). Therefore, specifications permit some tolerance. For instance, AWPA Processing and Treatment Standard T1 for Southern Pine poles requires that 89 mm (3.5 in.) or 90% of the sapwood thickness be penetrated for waterborne preservatives. The requirements vary, depending on the species, size, class, and specified retention levels.

Preservative retentions are typically expressed on the basis of the mass of preservative per unit volume of wood within a prescribed assay zone. The retention calculation is not based on the volume of the entire pole or piece of lumber. For example, the assay zone for Southern Pine poles is between 13 and 51 mm (0.5 and 2.0 in.) from the surface. To determine the retention, a boring is removed from the assay zone and analyzed for preservative concentration. The current issues of these specifications should be referenced for up-to-date recommendations and other details. In many cases, the retention level is different depending on species and assay zone. Higher preservative retention levels are specified for products to be installed under severe climatic or exposure conditions.

Satisfactory Penetration

Heavy-duty transmission poles and items with a high replacement cost, such as structural timbers and house foundations, are required to be treated to higher retention levels. Correspondingly, deeper penetration or heartwood limitations are also necessary for the same reasons. It may be necessary to increase retention levels to ensure satisfactory penetration, particularly when the sapwood is either unusually thick or is somewhat resistant to treatment.

To reduce bleeding of the preservative, however, it may be desirable to use preservative-oil retention levels less than the stipulated minimum. Older specifications based on treatment to refusal do not ensure adequate penetration or retention of preservative, should be avoided, and must not be considered as a substitute for results-type specification in treatment.

Recycling and Disposal of Treated Wood

Treated wood is not listed as a hazardous waste under Federal law, and it can be disposed of in any waste management facility authorized under State and local law to manage such material. State and local jurisdictions may have additional regulations that impact the use, reuse, and disposal of treated wood and treated-wood construction waste, and users should check with State and local authorities for any special regulations relating to treated wood. Treated wood must not be burned in open fires or in stoves, fireplaces, or residential boilers, because the smoke and ashes may contain toxic chemicals.

Summary

Wood destroying fungus (fungi, plural) causes more damage to structures than all the fires, floods, and termites combined! Wood decaying fungus requires four fundamentals to survive which are oxygen, favorable temperatures, water, and food. Fungus occurs generally when the moisture content of wood exceeds 20 to 30 percent, coupled with optimal temperatures (32˚ – 90˚ F), an adequate supply of oxygen and a suitable source of energy and nutrients. Fungus is a plant that lack chlorophyll. Unable to manufacture its own food, it feeds off of cells in the wood. The fungus secretes enzymes that break down the wood into usable food. Fungi will significantly reduce the strength of the wood, if the condition continues over a period of time.

A wood-decay fungus is any variety of fungus that consumes moist wood, causing it to rot. There is a wide variety of wood-decay fungi and they are best identified by the type of rot that they cause, the most common including soft, white, and brown rot.

Wood-Decaying Fungi Factors
Wood decaying fungi requires four specific things to thrive: oxygen, favorable temperatures, water, and food. This happens when the moisture content of wood exceeds 20 to 30 percent, coupled with an ideal temperature of between 40 and 90 degrees Fahrenheit. Your best bet in determining and preventing the type of fungi that is within your home is having a professional who is an expert in wood-destroying pests and organisms to come in and assess the issue.

Wood-Decaying Fungi
There are different types of wood destroying fungus, each with identifying characteristics.

- **White rot** – breaks down all major wood components and commonly causes rotted wood to feel moist, soft and spongy, or stringy and to appear white bleached.
- **Brown rot** – leaves a brown residue of lignin and the affected wood is usually dry and fragile, and readily crumbles into cubes. Brown rot is generally more serious than white rot.
- **Soft rot** – typically occurs in wood of high water content and high nitrogen content. Soft rot fungi look like brown rot. They are most commonly found in rotting window frames, wet floor boards and fence posts, etc.

Treatment Review

Treatment of wood destroying fungus requires borates. Borates are highly destructive to all wood destroying organisms and, unlike other wood preservatives, they are non-volatile, odorless, and are less toxic than table salt. They do not discolor the wood, are non-corrosive, environmentally safe and effective in controlling more than 45 different species of wood destroying fungi.

After treatment has been completed the fungi will begin to die and dry up. Occasionally the dead fungi will emit an unpleasant odor as it decomposes. This will only last a couple of days and may be minimized with the circulation of fresh air.

Although borates will kill wood destroying fungi, it will not add strength to the damaged wood. The most effective and common method for moderate to severe damage is to replace the damaged wood. However, if only a small area is affected, borates and reinforcing the damaged wood are a cost-effective alternative.

When mold fungus is found growing on wood you should kill it as soon as possible. Mold is not only unsightly and potentially dangerous, but it can also ruin wood. If left untreated, wood infected with mold will deteriorate and eventually become unusable.

Eliminating Moisture
The fungus that causes dry rot thrives on wood fibers, but it also needs moisture to survive, so the first step in treating it is to find out where the moisture is coming from. There may be a roof, wall or plumbing leak or a combination of high humidity and poor venting that is causing condensation to collect. It's also possible that the wood is too close to the concrete foundation or that the lumber company didn't dry it enough before selling it. After you've tracked down and addressed the cause of the moisture, the wood may need several weeks to dry out completely.

Fungus Treatment
You can use borate chemicals to create an environment in the wood that repels the fungus that causes dry rot. Borates dissolve in water, so you can make your own fungus repellant by mixing borax, or sodium borate, in water, or you can use a pre-mixed product. Soak the wood thoroughly with the solution; when it dries out, the borate remains in the fibers and prevents mold growth. Borates leach out of the wood if it gets wet, making it doubly important to prevent moisture from affecting the wood.

Strengthening the Wood
Wood that has been eaten by dry rot loses its structural integrity, and when this becomes serious enough, you have to replace the wood. If you eliminate the mold soon enough, however, you can save the wood by filling the damaged part with epoxy filler. To do this, scrape out all the damaged wood with a screwdriver or putty knife and trowel in the filler, completely filling the voids that you hollowed out. If you suspect rot deeper in the wood, drill holes into it so the filler can penetrate more deeply. When the filler dries, it will be stronger than the wood itself.

Mold is a Fungus
Mold is a fungus, and it grows virtually everywhere on Earth. Lately, mold has become a hot topic because of increasing awareness about its potential health hazards. People aren’t exactly sure how many mold species there are, but estimates range anywhere between tens of thousands to over a few hundred thousand. Some of these different types aren’t dangerous to human health, while others lead to chronic and severe health conditions.

When addressing any mold growth in your home, it’s important to understand which type of mold you’re dealing with. Each one has its own characteristics, growth patterns and health effects to be aware of. It’s also necessary to be aware of the common places to find mold in your house so you can prevent the spread of these harmful and toxic substances. Check places like bathrooms, basements, roofs and window seals for harmful mold growth.

Topic 6 - Fungus and Wood Fungi Section Post Quiz

1. A fungus or fungi is a member of a large group of eukaryotic organisms that includes microorganisms such as yeasts and molds, as well as the more familiar mushrooms. These organisms are classified as a kingdom, Fungi, which is separate from_________________.

2. Abundant worldwide, most fungi are inconspicuous because of the small size of their structures, and their cryptic lifestyles in soil, on dead matter, and as symbionts of plants, animals, or other fungi. They may become noticeable when fruiting, either as mushrooms or _________ .

Pathogens and Parasites

3. Some carnivorous fungi, like Paecilomyces lilacinus, are predators of________________, which they capture using an array of specialized structures such as constricting rings or adhesive nets.

Wood Decaying Fungi

4. The spore-producing bodies are the fruiting bodies of the fungus and may take the form of mushrooms, shelf like brackets, or flattened, crust like structures. Fine, threadlike fungal strands called _______________grow throughout the wood and digest parts of the wood as food. In time, the strength and other properties of the wood are destroyed.

Life Cycle & Habits

5. Decay fungi are living organisms which send minute threads called "______________" through damp wood, taking their food from the wood as they grow. Gradually, the wood is decomposed and its strength is lost.

Rot Control Measures
Prevention
Chemical Treatment

6. Shell-Guard® and Guardian® are labeled for protection and treatment against decay fungi and wood destroying insects. These two products are formulated with propylene and polyethylene glycols, making them doubly safe to use. Since these products are borate based, the protection is permanent after application. Guardian® is the highest concentration available in a formulated borate product. ________________into holes to provide fast penetration into problem areas. Rapid diffusion is assured by the formulated carriers. Holes can be sealed to match the original finish of the wood.

Treatment of Wood Infested by Decay and/or Wood

7. Boracare application methods for treating beetle and decay infestations are similar. Treat the infested and surrounding area with Boracare according to label directions. When practical, infect diluted Boracare solution into beetle emergence holes and galleries. It is important to treat the_________________. If only a small portion of a wood member is treated there is a possibility that the amount of active ingredient in the treated area may eventually diffuse to a level below that needed for effective control.

Molds

8. Many people confuse the presence of molds with decay fungi. Although molds are a form of fungi, they typically grow on the surface of wood and generally do not weaken the wood's strength. However, the presence of mold is a good indication that the moisture level in the wood is high enough to also support the growth of decay fungi. _______________used to prevent decay fungi will also remove conditions favorable for mold growth.

Can I Clean the Mold from the Wood?

9. The decision to clean mold from lumber depends on the amount of mold present and how likely it is to be disturbed. In nearly all cases, mold cleaning should be undertaken only after any ____________________are resolved. For any mold clean up that may generate large amounts of dust, basic personal protection equipment such as rubber gloves, eye protection and a high-quality pollen or dust mask should be worn. Clean-up of small spots or areas of mold generally does not require any special protective equipment.

Mold Summary

10. Molds play an important role in nature by breaking down organic materials. We routinely encounter mold spores as part of everyday life, in both outdoor and indoor environments. In most cases, the body's _________________normally provide defense mechanisms that protect it from health effects of regular exposure to molds.

Answers

1. Plants, animals, and bacteria, 2. Molds, 3. Nematodes, 4. Mycelia, 5. Hyphae, 6. It can be directly injected, 7. Entire infested wooden member, 8. Moisture control methods, 9. Moisture problems, 10. Immune and respiratory systems

Glossary

Abdomen: The hindmost of the three main body divisions of an insect.
Acaricide: A chemical employed to kill and control mites and ticks.
Acetyl choline: A substance present in many parts of the body of animals and important to the function of nerves.
Acrostichal Bristles: The two rows of hairs or bristles lying one on either side of the mid-line of the thorax of a true fly.
Active Space: The space within which the concentration of a pheromone or other behaviorally active substance is concentrated enough to generate the required response, remembering that like light and sound pheromones become more dilute the further they radiate out from their source.
Aculeate: (Hymenoptera):Those members of the Hymenoptera which possess a sting.
Acuminate: Tapering to a long point.
Adeagus: The part of the male genitalia which is inserted into the female during copulation and which carries the sperm into the female. Its shape is often important in separating closely related species.
Adecticous: Of pupa: referring to the state in which the pupa does not possess movable mandibles, the opposite being Decticous.
Aestivation: Summer dormancy, entered into when conditions are unfavorable for active life; i.e. it is too hot or too dry.
Age Polytheism: The regular changing of roles of colony members as they get older.
Air sac: A dilated portion of a trachea
Alar Squama: The middle of three flap-like outgrowths at the base of the wing in various flies.
Alate: Winged; having wings.
Alitrunk: Name given to the thorax and propodeum of 'wasp-waisted' hymenopterans.
Allopatric: Two or more forms of a species having essentially separate distributions.
Alternating Generations: When two generations are produced within a life cycle, each producing individuals of only one sex, either male first and then female or visa-versa.
Alula: In insects (not birds) the outermost of the three flap-like outgrowths at the base of the wing in various flies: really a part of the wing membrane.
Aldrin: (common name). A synthetic insecticide; a chlorinated hydrocarbon of not less than 95 per cent 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4:5,8-dimethanonaphthalene; moderately toxic to mammals, acute oral LD,, for rats 44 mg/kg; phytotoxicity: none when properly formulated, but some crops are sensitive to solvents in certain formulations.
Aliphatic: A term applied to the "open chain" or fatty series of hydrocarbons.
Alkaloids: Substances found in plants, many having powerful pharmacologic action, and characterized by content of nitrogen and the property of combining with acids to form ‘salts'.
Alloparental: When individuals other than the parent assist in caring for that parent’s offspring.
Altruistic: Self-destructive, or potentially self-destructive, behaviour performed for the benefit of others.
Ambrosia: The fungus cultivated by wood-boring beetles of the family Scolytidae
Ametabola: The insects which develop without metamorphosis, namely the Protura, Thysanura, and Collembola.
Amide: Compound derived from carboxylic acids by replacing the hydroxyl of the -

COOH by the amino group, $-NH_2-$.
Amine: An organic compound containing nitrogen, derived from ammonia, NH_3, by replacing one or more hydrogen atoms by as many hydrocarbon radicals.
Amino acid: Organic compounds that contain the amino (NH,) group and the carboxyl (COOH) group. Amino acids are the "building stones" of proteins.
Ammonia: A colorless alkaline gas, NH_3, soluble in water.
Anal: Pertaining to last abdominal segment which bears the anus.
Anal angle: The small apical area enclosed by the inner and outer margins of the hindwing.
Anal fold: A fold in the inner margin of the hindwing.
Anaplasmosis: Infection with Anaplasma, a genus of Sporozoa that infests red blood cells.
Anasa wilt: A wilt disease of cucurbits caused solely by the feeding of the squash bug, no parasitic microorganism involved.
Androconia: (singula = Androconium) In male butterflies, specialized wing scales (often called scent scales) possessing special glands which produce a chemical attractive to females.
Anemic: Deficient in blood quantity or quality.
Annulate: Formed in ring-like segments or with ring-like markings.
Antenna: (pl., antennae). Pair of segmented appendages located on the head and usually sensory in function - the 'feelers'.
Antennation: Touching with the antenna
Antenodal Veins: Small cross-veins at the front of the dragonfly or damselfly wing, between the wing base and the nodus.
Anterior: Concerning or facing the front, towards the head.
Antibiosis: An association between two or more organisms that is detrimental to one or more of them.
Anticoagulin: A substance antagonistic to the coagulation of blood.
Anus: The posterior opening of the digestive tract.
Anal veins: The hindmost, or most posterior, longitudinal wing veins.
Aorta: The anterior, non-chambered, narrow part of the insect heart which opens into the head.
Apex: The point where the costal vein and the outer margin of the forewing meet.
Apiary: A place where bees are kept, normally a group of hives.
Apical: At or concerning the tip or furthest part of any organ: apical cells, for example, are at the wing-tip.
Apical area: Of the forewing, the area just inside of and contiguous with the apex.
Appendage: Any limb or other organ, such as an antenna, which is attached to the body by a joint
Appendix: In insects, a short vein, especially a short continuation after the main vein has changed direction.
Apterous: Without wings.
Apterygote: Any member of the Apterygota -primitively wingless insects (i.e. insects which have never developed wings during their evolutionary history); in modern classifications this includes the Thysanura but not Collembola Diplura and Protura which are no longer considered insects, but are termed Hexapods instead. **Aquatic:** Living in water.
Arachnida: A class of arthropods which include the scorpions, spiders, mites, ticks, among others.
Arboreal: Living in, on, or among trees.
Arista: A bristle-like outgrowth from the antenna in various flies.

Aristate: Bearing an arista or bristle.
Arolium: A small pad between the claws on an insect's foot. Usually very small, but well developed in grasshoppers and some other insects.
Arrhenoyoky: The production of males from unfertilized eggs.
Arthropoda: A phylum of animals with segmented body, exoskeleton, and jointed legs.
Arthropods: Animals belonging to the phylum Arthropoda.
Asymmetrical: Organs or body parts not alike on either side of a dividing line or plane.
Astelocyttarus: Pertaining to nests, normally those of social wasps, in which the come is attached directly to the support.
Aster yellows: A virus disease of many kinds of plants transmitted by the six spotted leaf hopper and characterized by stunting of plants, sterility, and chlorosis in foliage.
Attractants: Substances which elicit a positive directional response; chemicals having positive attraction for animals such as insects, usually in low concentration and at considerable distances.
Axon: The process of a nerve cell that conducts impulses away from the cell body.
Alates: Winged forms of insects.
Anthocorids: A true bug in the family Anthocoridae.
Aphid: An insect in the family Aphidiidae which are sometimes called plant lice.

Basal: Concerning the base of a structure - that part nearest the body. Basal cells in Diptera are generally small cells near the base of the wing.
Basitarsus: The 1st segment of the tarsus - usually the largest.
Batumen: A protective layer of propilis or hard cerumen that encloses the nest cavity of a stingless bee colony.
Benzene hexachloride: (chemical name) or BHC. (common name). A synthetic insecticide, a chlorinated hydrocarbon, 1,2,3,4,5,6-hexachlorocvclohexane of mixed isomers; slightly more toxic to mammals than DDT, acute oral LD51 for rats about 200 mg/kg; phytotoxicity: more toxic than DDT, interferes with germination, suppresses growth and reduces yields except at low concentration; certain crop plants, as potato absorb crude BHC with consequent tainting of tubers.
Bilateral symmetry: Similarity of form, one side with the other.
Biological control: The control of pests by employing predators, parasites, or disease; the natural enemies are encouraged and disseminated by man.
Bionomics: The study of the habits, breeding, and adaptations of living forms.
Bipectinate: Feathery, with branches growing out on both sides of the main axis: applied mainly to antennae.
Bisexual: Having two sexes distinct and separate; i.e. a species with males and females.
Bivouac: The mass of army ant workers within which the queen and brood, live while the colony is not on the move.
Bivoltine: Having two generations per year.
Blastogenesis: The origination of different castes, within a species, from the egg by means other than genetic.
Book lung: A respiratory cavity containing a series of leaf like folds.
Bot: The larva of certain flies that are parasitic in the body of mammals.
Brachypterous: With short wings that do not cover the abdomen, used of individuals of a species which otherwise has longer wings.
Bract: A small leaf at the base of the flower.
Brood: In insects, a group of individuals of a given species which have hatched into young or which have become adult at approximately the same time and which live

together in a defined and limited area. Often referring to the immature stages of ants, bees and wasps.
Bubonic plague: A bacterial disease of rodents and man caused by *Pasteurella pestis* and transmitted chiefly by the oriental rat flea; marked by chills, fever, and inflammatory swelling of lymphatic glands.
Budding: Colony fission, the creation of new colonies by the departure of one or more reproductive females accompanied by a group of workers specifically to establish a new colony.
Bursa Copulatrix: That part of the female genitalia which receives the aedeagus and sperm during copulation. Its structure is often important in separating closely related species.

Caecum: (pl., caeca). A sac or tubelike structure open at only one end.
Calcareous: Referring to soils or rocks, possessing those elements which result in alkaline or basic reactions.
Callow: Newly enclosed workers in social insect colonies whose exoskeletons are still soft and whose colour has not fully matured.
Callus: A rounded swelling: applied especially to swollen regions at the front or back of the thorax in various flies.
Calypter: Innermost of the three flap-like outgrowths at the base of the wing in various flies. Also known as the thoracic squama, it generally conceals the haltere.
Calyptodomous: Of the nests of wasps, referring to those which are surrounded by an envelope.
Campodeiform: (applied to a larva) Grub-like, flattened and elongated with well-developed legs and antennae. Many beetle larvae are of this type, and so are those of the lacewings.
Capitate: With an apical knob-like enlargement.
Capitulum: Head-like structure of ticks which bears the feeding organs.
Carabiform larva: A larva shaped like the larva of a carabid beetle, that is etiolate, flattened, and with well-developed legs; with no filaments on the end of the abdomen.
Carbohydrate: Any of a group of neutral compounds made up of carbon, hydrogen, and oxygen; for example, sugar, starch, cellulose.
Cardo: The basal segment of the maxilla or secondary jaw.
Carina: A ridge or keel.
Carnivorous: Preying or feeding on animals.
Castes: Groups of individuals that become irreversibly behaviorally distinct at some point prior to reproductive maturity. One of three or more distinct forms which make up the population among social insects. The usual three castes are queen, drone (male), and worker. The termites and some of the ants have one or more soldier castes as well.
Caterpillar: The larva of a moth, butterfly, or saw-fly.
Catfacing: The injury caused by the feeding of such insects as plant bugs and stink bugs on developing fruit which results in uneven growth and a deformed mature fruit.
Cauda: The pointed end of the abdomen in aphids.
Caudal: Concerning the tail end.
Cell: An area of the wing bounded by a number of veins. A cell is closed if it is completely surrounded by veins and open if it is bounded partly by the wing margin.
Cellulose: An inert carbohydrate, the chief component of the solid framework or woody part of many plants.
Cement layer: A thin layer on the surface of insect cuticles formed by the hardened secretion of the dermal glands.

Cephalic: Of or pertaining to the head.
Cephalothorax: A body region consisting of head and thoracic segments, as in spiders.
Cerci: (singular: cercus) The paired appendages, often very long, which spring from the tip of the abdomen in many insects.
Cerumen: A mixture of wax and propolis used by social bees in nest construction.
Cervical: Concerning the neck region, just behind the head.
Chaetae: Stiff hairs or bristles (singular: chaeta).
Chaetotaxy: The arrangement of the bristles or chaetae on an insect: especially important in the classification of the Diptera, Collembla and several other groups.
Chelicera: (pl., chelicerae). The anterior pair of appendages in arachnids, the fangs.
Chigger: The parasitic larva of trombiculid mites.
Chitin: The tough horny material, chemically known as a nitrogenous polysaccharide, which makes up the bulk of the insect cuticle, also occurs in other arthropods.
Chorion: The inner shell or covering of the insect egg. Another name for the egg shell.
Chromosomes: At cell division the dark-staining, rod-shaped structures which contain the hereditary units called genes.
Chrysalis: The pupa of a butterfly.
Ciliated: Bearing minute hairs (cilia).
Cladogram: A diagram showing nothing more than the sequence in which groups of organisms are interpreted to have originated and diverged in the course of evolution.
Class: A division of the animal kingdom lower than a phylum and higher than an order, for example the class Insecta.
Clavate: Club-shaped, with the distal end swollen: most often applied to antennae.
Claustral Foundation: A way of setting up a new colony by a queen, or king and queen in the termites, which involves her/them sealing her/themselves away in a small chamber and raising the first group of workers entirely (or almost so) on stored body reserves (fat and often the flight muscles).
Clavus: Posterior part of the forewing of heteropteran bugs.
Cleptoparasitism: Where one female uses the resources and nest of another individual (of either the same or a different species) to provide for her young, thus usurping the owner's efforts and preventing her from using them.
Cline: A progressive, usually continuous change in one or more characters of a species over a geographic or altitudinal range.
Club: The thickened terminal (farthest from the head) end of the antennae.
Clypeus: Lowest part of the insect face, just above the labrum.
Coarctate: (applied to pupae) Enclosed within the last larval skin, which therefore acts as a cocoon and protects the pupa. Such pupae are found in flies (Diptera, of the sub-order Cyclorrhapha.).
Cocoon: A case, made partly or completely of silk, which protects the pupa in many insects, especially the moths. The cocoon is made by the larva before it pupates.
Colony. A small or large locally isolated population. Of social insects, a group which co-operates in the construction of a nest and in the rearing of the young.
Comb: The grouped cells of the nests of many social hymenoptera.
Comb: A group of spines on the leg of an insect specifically used for cleaning other parts of the insect's body.
Commensalism: Symbiosis, one or more individuals from two or more species living together such that one benefits but neither loses fitness.
Commissure: A bridge connecting any two bodies or structures on a body.
Communal: Where females of one species co-operate in nest building, but not in brood care.
Complete metamorphosis or Complex metamorphosis: Metamorphosis in which the

insect develops through four distinct stages, e.g.., ova or egg, larva, pupa, and adult or imago; the wings (when present) develop internally during the larval stage.
Compound eye: An eye consisting of many individual elements or ommatidia each of which is represented externally by a facet. A large grouping of light gathering organs that allow the insect to detect color and motion. For most insects, resolution is not very good.
Connective: A longitudinal cord of nerve fibers connecting successive ganglia.
Contiguous: Touching - usually applied to eyes (see also Holoptic).
Conspecific: Belonging to the same species.
Construction Gland: A gland of wasps producing a size-like substance which enables them to make paper out of wood-pulp.
Copularium: The first chamber built by a newly mated pair of sexual termites.
Corbicula: The pollen basket on the hind leg of many bees, formed by stout hairs on the borders of the tibia.
Corium: The main part of the forewing of a heteropteran bug.
Cornicle: One of the pair of small tubular outgrowths on the hind end of the aphid abdomen.
Corpora allata: A pair of small endocrine glands located just behind the brain.
Cosmopolitan: Occurring throughout most of the world.
Costa: One of the major longitudinal veins, usually forming the front margin of the wing and usually abbreviated to C. The costal margin is the front edge of the wing.
Costal Cell: The cell between the costa and the sub-costal vein.
Costal Fold: A narrow, thin membrane folded back on the upper surface of the costa of the forewing of butterflies, it contains androconia
Coxa: The basal segment of the insect leg, often immovably attached to the body.
Crawler: The active first instar of a scale insect.
Cremaster: The cluster of minute hooks (sometimes just one larger hook) at the hind end of a lepidopterous pupa: used to grip the pupal support.
Crochets: (Pronounced crow-shays). Hooked spines at tip of the prolegs of lepidopterous larvae.
Crop: The dilated section of the foregut just behind the esophagus.
Cross-vein: A short vein joining any two neighboring longitudinal veins.
Cryptic: Coloring and or pattern adapted for the purpose of protection from predators or prey by concealment.
Cryptobiotic: Leading a hidden or concealed life.
Cubitus: One of the major longitudinal veins, situated in the rear half of the wing and usually with 2 or 3 branches: abbreviated to Cu.
Cuneus: A more or less triangular region of the forewing of certain heteropteran bugs, separated from the corium by a groove or suture.
Cursorial: Adapted for running.
Cuspidal: Two segments of curved lines meeting and terminating at a sharp point.
Cuticle: The outer noncellular layers of the insect integument secreted by the epidermis.
Cyclorrhaphous Diptera: The group of flies which emerge from the puparium through a circular opening at one end of the puparium. These flies belong to the more advanced families.
Cytology: The study of cells and their functions.
DDT: (common name). A widely used synthetic insecticide; a chlorinated hydrocarbon, dichloro diphenyl trichloroethane.
Dealate: Wingless as a result of the insect casting or breaking off its own wings, as in newly mated queen ants and termites.
Decticous: Of pupa: referring to the state in which the pupa possesses movable mandibles which can be used for biting, the opposite being Adecticous.

Dengue: (pronounced deng'e). A virus disease of man marked by severe pains in head, eyes, muscles, and joints and transmitted by certain mosquitoes.
Dentate: Toothed, possessing teeth or teeth like structures.
Denticulate: Bearing very small tooth-like projections.
Deutonymph: The third instar of a mite.
Diapause: A period of suspended animation of regular occurrence in the lives of many insects, especially in the young stages. A period of delayed development or growth accompanied by reduced metabolism and inactivity.
Diaphragm: A horizontal membranous partition of the body cavity.
Diet: Another word for the cube of food the insect feeds on.
Differentiation: Increase in visible distinctive morphology.
Dimorphic: Occurring in two distinct forms.
Dimorphism: A difference in size, form, or color, between individuals of the same species, characterizing two distinct types.
Discal: The central portion of a wing from the costa to the inner margin.
Discal Cell: Name given to a prominent and often quite large cell near the middle of the wing. The discal cell of one insect group may not be bounded by the same veins as that of another group.
Distad: In a direction away from the body.
Distal: Concerning that part of an appendage furthest from the body.
D.N.A. : An abbreviation for Dioxyribonucleic Acid, a large molecule which stores the data in our genes in the form of a 3 character code. D.N.A. is a self-replicating molecule.
Dorsal: On or concerning the back or top of an animal.
Dorsal Nectary Organ: In the larvae of many species of Lycaenidae (***Blue Butterflies***). A gland located in the dorsal region of the 7th abdominal segment, it secretes a sweet substance which is attractive to ants.
Dorsal ocellus: The simple eye in adult insects and in nymphs and naiads.
Dorsal shield: The scutum or sclerotized plate covering all or most of the dorsal surface in males and the anterior portion in females, nymphs, and larvae of hard-backed ticks.
Dorsal vessel: The part of the insect heart that contains valves and chambers.
Dorso-central Bristles: The 2 rows of bristles running along the thorax of a fly on the outer side of the acrostichal bristles.
Dorso-lateral: Towards the sides of the dorsal (upper) surface.
Dorso-ventral: Running from the dorsal (upper) to the ventral (lower) surface.
Dorsum: The upper surface or back of an animal.
Drone: The male honey bee.
Dulosis: The act of slave-making in ants; a species which makes a slave of another is often referred to as Dulotic.

Ecdysis: The molting process, by which a young insect changes its outer skin or pupal case.
Eclosion: Emergence of the adult or imago from the pupa
Ectoderm: The outer embryological layer which gives rise to the nervous system, integument, and several other parts of an insect.
Ectohormone: A substance secreted by an animal to the outside of its body causing a specific reaction, such as determination of physiological development, in a receiving individual of the same species.
Ectoparasite: A parasite that lives on the outside of its host.
Egg pod: A capsule which encloses the egg mass of grasshoppers and which is formed through the cementing of soil particles together by secretions of the ovipositing female.
Elateriform larva: A larva with the form of a wireworm; i.e. long and slender, heavily

sclerotized, with short thoracic legs, and with few body hairs.
Elbowed Antenna: Antenna, particularly of ants, in which there is a distinct angle between two of the segments - usually between the 1st and 2nd segments, in which case the 1st segment is usually much longer than the others.
Elytron: (plural elytra) The tough, horny forewing of a beetle or an earwig (See also Hemi-elytron)
Emarginate: With a distinct notch or indentation in the margin.
Emery's Rule: The rule resulting from the observation that species of social parasite are very closely related to their host.
Embolium: A narrow region along the front margin of the forewing in certain heteropteran bugs: separated from the rest of the corium by a groove or suture.
Empodium: An outgrowth between the claws of a fly's foot: it may be bristle-like.
Endemic: Restricted to a well-defined geographical region.
Endocrine: Secreting internally, applied to organs whose function is to secrete into blood or lymph a substance which has an important role in metabolism.
Endocuticle: The innermost layer of the cuticle.
Endoparasite: A parasite which lives inside its host's body. Most of the ichneumons, are endoparasites during their larval stages.
Endopterygote: Any insect in which the wings develop inside the body of the early stages and in which there is a complete metamorphosis and pupal stage.
Entomogenous: Growing in or on an insect, for example certain fungi.
Envelope: The carton or wax outermost later of the nest of a social insect, particularly those of wasps.
Enzyme: An organic catalyst, normally a protein formed and secreted by a living cell.
Epicuticle: The thin, non-chitinous, surface layers of the cuticle.
Epidermis: The cellular layer of the integument that secretes or deposits a comparatively thick cuticle on its outer surface.
Epigaeic: Living or foraging primarily above ground, compared to Hypogaeic the opposite.
Epimeron: The posterior part of the side wall of any of the three thoracic segments.
Epinotum: The first abdominal segment when it is fused with the last thoracic one, relating to the higher thin waisted hymenoptera. Also called a propodeum.
Epipharynx: A component of many insect mouth-parts which is attached to the posterior surface of the labrum or clypeus. In chewing insects, it is usually only a small lobe, but in the fleas it is greatly enlarged and used for sucking blood.
Epiproct: An appendage arising from the mid-line of the last abdominal segment, just above the anus. In the bristletails and some mayflies it is very long and forms the central '***tail***'
Episternum: The anterior part of the side wall of any of the three thoracic segments.
Epithelium: The layer of cells that covers a surface or lines a cavity.
Ergatogyne: Any female member of a eusocial group whose morphological development is somewhere between that of a worker and a queen.
Eruciform: (applied to a larva) Caterpillar like; more or less cylindrical with a well-developed head and stumpy legs at the rear as well as the true thoracic legs. The caterpillars of butterflies and moths are typical examples.
Eusocial: A species which lives in a society such that individuals of the species cooperate in caring for the young, which not all of them have produced; there is a reproductive division of labor, with more or less sterile individuals working on behalf of fecund individuals; and there is an overlap of at least two generations in life stages capable of contributing to colony labor, so that offspring assist parents during some period of their life.

Exarate Pupa: A pupa in which all the appendages, legs etc., are free and capable of movement.
Excavate: Hollowed out: applied to the coxae of many beetles, which are hollowed out to receive the femora when the legs are folded.
Excretion: The elimination of the waste products of metabolism.
Exocuticle: The hard and usually darkened layer of the cuticle lying between the endocuticle and epicuticle.
Exoskeleton: Collectively the external plates of the body wall.
Exopterygote: Any insect in which the wings develop gradually on the outside of the body, in which there is only a partial metamorphosis and no pupal stage.
Exuvia: The cast-off outer skin of an insect or other arthropod.
Eye-cap: Hood formed by the base of the antenna and partly covering the eye in certain small moths.

Facet: The surface of an ommatidium - one of the units making up the compound eye.
Family: A taxonomic subdivision of an order, suborder, or superfamily that contains a group of related subfamilies, tribes and genera. Family names always end in -idae.
Fascicle: A small bundle; the bundle of piercing stylets of insects with piercing sucking mouthparts.
Femur: The 3rd (counting out from the body) and often the largest segment of the insect leg.
Filament: A thread-like structure, especially one at the end of an antenna.
Filiform: Thread-like or hair-like, applied especially to antennae.
Flabellate: With projecting flaps on one side, applied especially to antennae.
Flagellum: The distal (furthest away from the body) part of the antenna, beyond the 2nd segment.
Foregut: The anterior part of the alimentary canal from the mouth to the midgut.
Fossorial: Adapted for digging.
Foveola: (pl. foveolae) One of the paired depressions on each side of the vertex in grasshoppers.
Frass: Another term for larval insect droppings or excretion.
Frenulum: The wing-coupling mechanism found in many moths.
Frons: Upper part of the insect face, between and below the antennae and usually carrying the median ocellus or simple eye. In true flies (Diptera) it occupies almost all of the front surface of the head apart from the eyes.
Frontal Bristles: The two vertical rows of bristles running down the face of a fly from the ocelli to the antennae
Fronto-orbital Bristles: The short row of bristles on each side of a fly's head between the eye and the frontal bristles.
Furcula: The forked spring of a springtail.
Fuscous: Smokey grey-brown in colour, normally applied to wings.

Galea: the outer branch of the maxillae, the inner one being the lacinia.
Gall: An abnormal growth of a plant caused by the presence in its tissues of a young insect or some other organism. Aphids, gall wasps, and gall midges are among the major gall-causing insects.
Ganglion: A nerve mass that serves as a center of nervous influence.
Gastric caeca: The sac-like diverticula at the anterior end of the midgut.
Gaster: The hymenopteran abdomen - apart from the 1st segment (the propodeum) which is fused to the thorax. The front part of the gaster often forms a narrow waist.

Gena: The cheek - that part of the head below and behind the eye.
Genal Comb: A row of stout spines on the lower border of the cheek of certain fleas.
Generation: The group of individuals of a given species that have been reproduced at approximately the same time; the group of individuals of the same genealogical rank.
Geniculate: Abruptly bent or elbowed (see Elbowed Antenna).
Genital claspers: Organs of the male genitalia which serve to hold the female during copulation.
Genitalia: The copulatory organs of insects and other animals. The shape and arrangement of the genitalia are often used to distinguish closely related and otherwise very similar species.
Genotype: The total genetic character of an organism, i.e. all its D.N.A. or genes
Genus: A group of closely related species (plural: genera). The name of the genus is incorporated into the scientific names of all the member species: *Pieris napi* and *Pieris rapae*, for example, both belong to the genus *Pieris*.
Gill: Breathing organ possessed by many aquatic creatures, including numerous young insects. Insect gills are usually very fine outgrowths from the body and they contain numerous air-tubes, or tracheae. Oxygen passes into the tubes from the water by diffusion.
Girdle: A silken thread supporting the midsection of a pupa.
Glabrous: Without hairs.
Glossa: (plural glossae) One of a pair of lobes at the tip of the labium or lower lip: usually very small, but long in honey bees and bumble bees, in which the two glossae are used to suck up nectar.
Gnathosoma: The anterior part of the body of mites and ticks which bears the mouth and mouthparts.
Gregarious: Living in groups.
Grub: A scarabaeiform larva, i.e. a thick bodied larva with thoracic legs and well developed head; usually sluggish.
Gynandromorph: An individual creature with a mixture of male and female characteristics. One half of the body may be male and the other half female. This is particularly noticeable when it occurs among the blue butterflies and others in which the sexes are differently colored.

Haemolymph: The blood plasma or liquid part of the blood, though generally synonymous for blood of insects.
Habitus: Body-build, general appearance.
Haltere: One of the club-shaped 'balancers' found on each side of the metathorax among the true flies (Diptera). They are the much-modified hind wings.
Hamuli: The minute hooks on the front edge of the hind wing of bees and other hymenopterans, used to link the front and hind wings together. The hook which holds the springtail's spring in place is also called the hamula.
Haustellate: Adapted for sucking liquids rather than biting solid food.
Heart: The chambered, pulsatile portion of the dorsal blood vessel.
Head: The anterior body region of insects which bears the mouthparts, eyes, and antennae.
Hematophagous: Feeding or subsisting on blood.
Hemi-elytron (plural hemi-elytra)**:** The forewing of a heteropteran bug, differing from the beetle elytron in having the distal portion membranous.
Hemimetabola: Insects with simple metamorphosis, with no pupal stage.
Hemimetabolous: Having an incomplete metamorphosis, with no pupal stage in the life

history.
Hermaphroditic: Containing the sex organs of both sexes in one individual.
Heteromerous: (of beetles) Having unequal numbers of tarsal segments on the three pairs of legs.
Hibernation: Dormancy during the winter.
Hindgut: The posterior part of the alimentary canal between the midgut and anus.
Histosiphon: Same as stylostome. The tube formed by the host as a result of the feeding of a chigger secreting salivary fluids, the chigger partially digests skin tissues, which induces the host to form a proteinaceous tube walling off the injury.
Holometabola: The higher insects which have complex metamorphosis.
Homologous: Organs or parts which exhibit similarity in structure, in position with reference to other parts, and in mode of development, but not necessarily similarity of function, are said to be homologous.
Holometabola: The higher insects which have complex metamorphosis.
Holometabolous: Having a complete metamorphosis, with larval and pupal stages in the life history.
Holoptic: With the eyes touching or almost touching on the top of the head: used mainly when describing flies (Diptera).
Holotype: The type specimen of a species is the actual insect from which the original description of that species was produced. If several specimens were used for this purpose, one of them should have been designated as the type. Because the type can be of only one sex, it is usual to designate a certain individual of the opposite sex as the allotype. The original type specimen is then called the holotype.
Homonym: A scientific name which has been given to two different species. When such an instance comes to light one of the species must be given another name.

Hormone: A chemical substance formed in some organ of the body, secreted directly into the blood, and carried to another organ or tissue where it produces a specific effect.
Honeydew: The sweet liquid emitted from the anus of aphids and some other sap sucking bugs.
Horn: A long spiked projection from the rear of the larva. It may serve as camouflage. Although all *Manduca* emerge with the horn, many loose it during larval life. Sometimes it's referred to as the dorsal horn.
Host: The organism in or on which a parasite lives; the plant on which an insect or other arthropod feeds.
Humeral Angle: The front basal part of the wing, close to its attachment to the body.
Humeral Vein: A small cross-vein running from the costa to the sub-costa in the humeral (basal) region of the wing.
Hyaline: Clear and colorless, like the wings of most dragonflies.
Hygrophilus: Moisture loving.
Hypermetamorphosis: A type of life history in which the larvae adopts 2 or more distinct forms during its development.
Hyperparasite: A parasitic organism which attacks another parasite.
Hypognathous: Having a vertical head and face with the mouth-parts at the bottom.
Hypopharynx: A component of the insect mouth-parts arising behind the mouth and just in front of the labium or lower lip. Usually short and tongue-like in species with biting jaws, but often drawn out to form a tube for the salivary duct in those species with sucking mouths.
Hypopleural Bristles: A curved row of bristles on the side of the thorax of certain true flies just below and in front of the haltere and just above the base of the hind leg.
Hypostome: In ticks, the median ventral dart-like mouthpart that is immovably attached

to basal part of the capittilum.
Hysterosoma: In mites, the posterior part of the body when there is a demarcation of the body between the second and third pair of legs.

Imago: The adult insect (Plural imagines)
Incomplete metamorphosis or Simple metamorphosis. Metamorphosis in which the wings (when present) develop externally during the immature stage and there is no prolonged resting stage (i.e. pupa) preceding the last molt; stages included are the egg, nymphal, and adult. Also called gradual or partial metamorphosis, and paurometabolous development.
Inquiline. A creature that shares the home of another species without having any obvious effect on that species.
Insecta. A 'class' of the 'phylum' Arthropoda, distinguished by adults having three body regions: head, thorax, and abdomen; and by having the thorax three-segmented with each segment bearing a pair of legs.
Instar. The stage in an insect's life history between any two molts. A newly-hatched insect which has not yet molted is said to be a first-instar nymph or larva. The adult (imago) is the final instar. The insect at the various times during larval development.
Integument. The insect's outer coat.
Intermediate host. The host which harbors the immature stages or the asexual stages of a parasite, a separate organism to that which harbors the sexual stage.
Intercalary Vein. An additional longitudinal vein, arising at the wing margin and running inwards but not directly connected to any of the major veins.

Joint: Strictly speaking, an articulation between neighboring parts, such as the femur and tibia of the leg, but the word is commonly used as a synonym of segment - meaning any of the divisions of the body or its appendages.
Johnston's organ: A sense organ located in the second antennal segment of many insects and particularly well developed in male mosquitoes and certain other Diptera.
Jugum: A narrow lobe projecting from the base of the forewing in certain moths and overlapping the hind wing, thereby coupling the two wings together.

Keel: A narrow ridge: also called a carina.

Labellum: The expanded tip of the labium, used by many flies to mop up surface fluids.
Labial: Concerning the labium.
Labial palpus: (pl., labial palpi). The labial palps, One of the pair of sensory appendages (feeler-like and 2 to 5 segments long) of the insect labium.
Labium: The 'lower lip' of the insect mouth-parts, formed by the fusion of two maxilla-like appendages.
Labrum: The 'upper lip' of the insect mouth-parts: not a true appendage but a movable sclerite on the front of the head.
Labrum-epipharynx: A mouthpart composed of the labrum and epipharynx and usually elongate.
Lacinia: The inner branch of the maxilla, the outer one being the galea.
Lamella: A thin, leaf-like flap or plate, the name being applied to the outgrowths of certain antennae.
Lamellate: Possessing lamellae: applied especially to antennae.
Larva: Name given to a young insect which is markedly different from the adult:

caterpillars and fly maggots are good examples. The immature form of an insect that follows the egg stage. Larva is the singular form, larvae is plural.
Lateral : Concerning the sides.
Lateral ocellus: The simple eye in holometabolous larvae. Also called stemma (pl., stemmata).
Lateral oviduct: In insects, one of the paired lateral ducts of the female genital system connected with the ovary.
Life history: Habits and changes undergone by an organism from the egg stage to its death as an adult.
Ligulae: Name given to the lobes at the tip of the labium: usually divided into glossae and paraglossae.

Maggot. A vermiform larva; a larva without legs and without well-developed head capsule.
Malpighian tubes. Excretory tubes of insects arising from the anterior end of the hindgut and extending into the body cavity.
Mandible. The jaw of an insect. It may be sharply toothed and used for biting, as in grasshoppers and wasps, or it may be drawn out to form a slender needle as in mosquitoes. Mandibles are completely absent in most flies and lepidopterans.
Mandibulate. Having mandibles suited for biting and chewing.
Marginal Cell. One of a number of cells bordering the front margin of the wing in the outer region.
Maxilla. (plural maxillae) One of the two components of the insect mouth-parts lying just behind the jaws. They assist with the detection and manipulation of food and are often drawn out into tubular structures for sucking up liquids.
Maxillary. Concerning or to do with the maxillae.
Meconium. The reddish fluid ejected by a member of the lepidoptera after emerging from the pupa/chrysalis.
Media. The longitudinal vein running through the central region of the wing in most insects: often the 4th and abbreviated to M.
Median oviduct. In insects, the single duct formed by the merging of the paired lateral oviducts; this duct opens posteriorly into a genital chamber or vagina.
Membranous. Thin and transparent (in reference to wings); thin and pliable (in reference to integument).
Mesonotum. The dorsal surface of the 2nd thoracic segment - the mesothorax: usually the largest thoracic sclerite.
Mesopleuron. The sclerite or sclerites making up the side wall of the mesothorax.
Mesoscutellum. Hindmost of the three major divisions of the mesonotum, often triangular or shield-shaped: usually abbreviated to scutellum.
Mesoscutum. The middle and usually the largest division of the mesonotum.
Mesosternum. The ventral surface or sclerite of the mesothorax.
Mesothorax. The 2nd segment of the thorax.
Metamorphosis. Name given to the changes that take place during an insect's life as it turns from a young animal to an adult. These changes may be gradual and not too large, as in the grasshopper, and metamorphosis is then said to be partial or incomplete. On the other hand, the changes may be much greater and they may take place in one big step - as in the butterflies and moths, which change from caterpillars to adults during the pupal stage. Metamorphosis of this kind is said to be complete.
Metanotum. The dorsal surface of the metathorax. It is often very small and its sub-divisions are usually obscured.
Metapleuron. The sclerite or sclerites making up the side wall of the metathorax.

Metasternum. The ventral surface or sclerite of the metathorax.
Metatarsus. The basal segment of the tarsus or foot: usually the largest segment.
Metathorax. The 3rd and last segment of the thorax.
Micropyle. A minute opening or group of openings into the insect egg through which the spermatozoa enter in fertilization.
Microtrichia. Minute hairs projecting from the integument, they are formed around cellular filaments.
Midgut. The middle part of the alimentary canal and the main site of digestion and absorption.
Moniliform. (of antennae) Composed of bead-like segments, each well separated from the next.
Monophagous. Feeding upon only one kind of food, for example one species or one genus of plants.
Molt. To molt is to shed the outer covering of the body - the exoskeleton.
Myiasis. Infestation of the body by the larvae of flies.
Mandible: The chewing structures of the insect mouth.
Manduca quinquemaculata*:* The scientific name for the Tomato Hornworm.
Manduca sexta*:* The scientific name for the Tobacco Hornworm. *Sexta* refers to the six yellow spots on each side of the adult abdomen.
Metamorphosis: A change in form, structure or function as a result of development; specifically the physical transformation undergone by various animals during development after the embryonic state, as of the larva or an insect to the pupa, and the pupa to the adult.
Molt: A process that involves the building of a new exoskeleton and the casting off of the old exoskeleton.

Naiad: An aquatic, gill-bearing nymph.
Nasutus: (pl., nasuti). A type of soldier caste in certain termites; this form bears a median frontal rostrum through which it ejects a defensive fluid; the jaws are small or vestigial.
Nectar: The sugary liquid secreted by many flowers.
Nectary: A floral gland which secretes nectar.
Neurone: The entire nerve cell including all its processes.
Nit: The egg of a louse.
Nocturnal: Active at night.
Nodus: The kink or notch on the costal margin of the dragonfly wing. The name is also used for the strong, short cross-vein just behind the notch.
Notaulix: One of a pair of longitudinal grooves on the mesonotum of certain hymenopterans, dividing the mesonotum into a central area and two lateral areas (plural notaulices)
Notopleuron: A triangular area on the thorax of certain flies, just behind the humeral callus and occupying parts of both dorsal and lateral surfaces.
Notum: The dorsal or upper surface of any thoracic segment: usually prefixed by pro-, meso-, or meta- to indicate the relevant segment.
Nucleus: The spheroid body within a cell that has the major role in controlling and regulating the cell's activities and contains the hereditary units or genes.
Nurse cells: Cells that are located in the ovarian tubes of certain insects and that furnish nutriment to the developing eggs.
Nymph: Name given to the young stages of those insects which undergo a partial

metamorphosis. The nymph is usually quite similar to the adult except that its wings are not fully developed. It normally feeds on the same kind of food as the adult.

Obtect Pupa: A pupa in which the legs and other appendages are closely appressed to the rest of the body and not capable of free movement - as in the butterfly chrysalis.
Occipital Suture: A groove running around the posterior region of the head of some insects and separating the vertex from the occiput. On the sides of the head the same groove marks the posterior boundary of the cheeks or genae.
Occiput: Hindmost region of the top of the head, just in front of the neck membrane. In some insects it is separated from the vertex by the occipital suture, but it is not usually present as a distinct plate or sclerite.
Ocellar Bristles: Bristles arising around or between the ocelli in various flies.
Ocellar Triangle: A triangular area, usually quite distinct from the rest of the head, on which the ocelli of true flies are carried.
Ocelli: Larval light detecting organs. There are usually 5 or 6 ocelli around the edge of the mandibles. These are tiny dark spots forming a semi-circle.
Ocellus: (Plural Ocelli) One of the simple eyes of insects, usually occurring in a group of three on the top of the head, although one or more may be absent from many insects.
Oesophagus: The narrow part of the alimentary canal immediately posterior to the pharynx and mouth.
Ommatidium: (pl., ommatidia). One of the units which make up the compound eyes of arthropods.
Ootheca: (pl., oothecae). An egg case formed by the secretions of accessory genital glands or oviducts, such as the purse-like structure carried around by cockroaches or the spongy mass in which mantids lay their eggs
Oral Vibrissae: The pair of large bristles just above the mouth in certain flies: usually simply called vibrissae.
Order: A subdivision of a class or subclass containing a group of related families. Organophosphates. Organic compounds containing phosphorous; an important group of synthetic insecticides belong to this class of chemicals.
Oribatid mite: A mite belonging to the Oribatei, a large unit of mites containing about 35 families in the suborder Sarcoptiformes.
Oviparous: Producing eggs which are hatched outside the body of the female.
Ovipositor: The tubular or valved egg-laying apparatus of a female insect: concealed in many insects, but extremely large among the bush-crickets and some parasitic hymenopterans.
Ovoviviparous: Producing living young by the hatching of the egg while still within the female.

Palp: A segmented leg-like structure arising on the maxilla or labium. Palps have a sensory function and play a major role in tasting food.
Paraglossa: One of a pair of lobes at the outer edges of the tip of the labium: with the central glossae, the paraglossae make up the ligula.
Paraproct: One of the 2 lobes bordering the sides of the anus.
Parasite: An organism that spends all or part of its life in close association with another species, taking food from it but giving nothing in return. Ectoparasites live on the outside of their hosts, while endoparasites live inside the host's body.
Parthenogenesis: A form of reproduction in which eggs develop normally without being fertilized. This is the usual method of reproduction among some stick insect species and among some generations of gall wasps and aphids.

Pathogenic: Giving origin to disease.
Pecten: A comb-like structure found at the base of the antenna in some insects.
Pectinate: Having branches which arise from the main axis like the teeth of a comb: usually applied to antennae.
Pedicel: The 2nd antennal segment: the name is also given to the narrow waist of an ant.
Pedipalp: The second pair of appendages of an arachnid, used to crush prey.
Petiolate: Attached by a narrow stalk.
Petiole: The narrow waist of bees and wasps and some other hymenopterans: often known as the pedicel when referring to ants.
Pharynx: The anterior part of the foregut between the mouth and the esophagus.
Pheromone: A substance secreted by an animal which, when released externally (in small amounts), causes a specific reaction, such as stimulation to mate with or supply food to a receiving individual of the same species.
Phoresis: The usage by one animal of another solely as a means of transport, i.e. certain mites on various other insects.
Phylum (pl., phyla)**:**. A major division of the animal kingdom, containing various suborders and classes etc.
Phytophagous: Feeding upon plants.
Phytotoxic: Poisonous to plants.
Platyform larva: A very flattened larva.
Plumose: Feather-like, as in plumose antennae.
Pictured: A term used to describe wings, especially among the Diptera, which have dark mottling on them.
Pilose: Densely clothed with hair.
Pleural: Concerning the side walls of the body.
Pleural Suture: A vertical or diagonal groove on each of the thoracic pleura, separating the episternum at the front from the epimeron at the back.
Pleuron: The side wall of a thoracic segment.
Plumose: With numerous feathery branches: applied especially to antennae.
Pollen: The mass of microspores or male-fertilizing elements of flowering plants.
Pollen Basket: The pollen-carrying region on the hind leg, of a bee: also known as the corbicula.
Pollinate: To transfer pollen grains from a stamen to a stigma or ovule of a plant.
Polyembryony: The production of several embryos from a single egg, as in some chalcids.
Polyphagous: Feeding on a variety of plants and or animals.
Porrect: Extending horizontally forward: applied especially to antennae.
Posterior: Concerning or facing the rear.
Postmentum: The basal region of the labium.
Postscutellum: A small division of the mesonotum just behind the scutellum: usually very small or absent, but well developed in certain flies.
Post-vertical Bristles: A pair of bristles - divergent, parallel, or crossing - on the back of the head of various flies, some way behind the ocelli.
Pre-apical: Arising just before the tip: many flies; for example, have pre-apical bristles just before the tip of the tibia.
Precostal area: The area in front of, or to the fore of, the costa.
Predaceous: Preying on other animals.
Predator. An animal that attacks and feeds on other animals, usually smaller and weaker than itself.
Prementum: The distal region of the labium, from which spring the labial palps and the

ligula.
Preovipositional period: The period between the emergence of an adult female and the start of its egg laying.
Prepupa: The last larval instar after it ceases to feed; often it takes on a distinctive appearance becoming quiescent and rather shrunken, and often looks dead.
Presumptive organization: Arrangement of cells in the embryo into groups which in normal development become a particular organ or tissue.
Pretarsus: In insects the terminal segment of the leg bearing the pretarsal claws.
Primary reproductives: Those members of a social group of insects whose primary role is reproduction, (often the founders of the colony). Compared to secondary reproductives that may produce some young but are primarily involved in some other activity.
Proctodeal valve: In insects, a valve in the anterior end of the hindgut that serves as an occlusor mechanism.
Proboscis: Name given to various kinds of sucking mouths in which some of the mouth-parts are drawn out to form tubes.
Prognathous: Having a more or less horizontal head, with the mouth-parts at the front.
Proleg: One of the fleshy, stumpy legs on the hind region of a caterpillar.
Pronotal Comb: A row of stout spines on the hind margin of the pronotum of certain fleas.
Pronotum: The dorsal surface or sclerite of the 1st thoracic segment.

Propodeum: The last abdominal segment in the hymenopteran group known as the Apocrita: it is completely fused with the thorax.
Propupa: In thrips, the next to the last nymphal instar in which the wing pads are present and the legs short and thick. Also in male scale insects.
Prosternum: Ventral surface of the 1st thoracic segment.
Proterosoma: In mites, the anterior part of the body when there is a demarcation of the body between the second and third pair of legs.
Prothoracic gland: One of a pair of endocrine glands located in the prothorax near the prothoracic spiracles.
Prothorax: The 1st or anterior thoracic segment.
Protonymph: The second instar of a mite.
Proventriculus: The posterior section of the foregut.
Pseudoscorpions: Small arachnids, seldom over 5 mm. long, scorpion-like in general appearance but without sting.
Pseudovipositor: The slender tube to which the posterior part of the abdomen is reduced in the female of certain insects.
Proximal: Concerning the basal part of an appendage - the part nearest to the body.
Pruinose: Covered with a powdery deposit, usually white or pale blue: especially applied to Odonata.
Pterostigma: A small coloured area near the wing-tip of dragonflies, bees, and various other clear-winged insects: also called the stigma.
Pterygote: Any member of the sub-class Pterygota, which includes all winged and some secondarily wingless insects.
Ptilinum: In Diptera, an organ that can be inflated to a bladder-like structure and thrust out through a frontal suture of the head at the time of emergence from the puparium.
Pubescent: Covered with short, soft hair
Pulvillus: The little pad beneath each claw on the foot of a fly.
Punctate: Covered with tiny pits or depressions, like the elytra of many beetles and the thoraxes of many hymenopterans.

Pupa: (pl., pupae). The 3rd stage in the life history of butterflies and other insects undergoing a complete metamorphosis during which the larval body is rebuilt into that of the adult insect a non-feeding and usually inactive stage.
Puparium: (pl., puparia). The barrel-shaped case which conceals the pupa of the house-fly and many other true flies. It is formed from the skin of the last larval instar.
Pupate: To turn into and exist as a pupa.
Pupiparous: Insects which give birth to fully-grown larvae which pupate almost immediately are said to be pupiparous. The main examples are various blood-sucking flies.
Proleg: The stubby, fleshy limbs attached to the abdomen of certain insect larvae, as in caterpillars. *M. sexta* larvae have four pairs of prolegs on the abdomen, with an additional pair at the very last segment.
Pupa: A non-feeding stage of development between the last larval and adult forms, characterized by many anatomical changes and, often, by enclosure in a cell or cocoon. Pupa is the singular form, pupae is plural.

Quadrilateral: A cell near the base of the damselfly wing, whose shape is important in separating the families.
Queen cell: The special cell in which a queen honey bee develops from egg to the adult stage.
Quinquemaculata: Refers to the five yellow spots on each side of the adult abdomen.

Race: A variety of a species; a subspecies.
Radial Sector: The posterior of the two main branches of the radius, usually abbreviated to Rs. It usually has several branches of its own.
Radius: One of the main longitudinal veins, running near the front of the wing and usually the 3rd and abbreviated to R. It gives off a posterior branch - the radial sector - and the smaller branches of these veins are numbered R1, R2, etc.
Raptorial: Adapted for seizing and grasping prey, like the front legs of a mantis.
Rectum: In insects, the posterior expanded part of the hindgut, typically pear-shaped.
Reticulate: Covered with a network pattern.
Reproductives: In termites, the caste of kings and queens; in other social insects, only the queens.
Rostrum: A beak or snout, applied especially to the piercing mouth-parts of bugs and the elongated snouts of weevils.
Rudimentary: Poorly or imperfectly developed.

Salivary glands: Glands that open into the mouth and secrete a fluid with digestive, irritant, or anticoagulatory properties.
Saprophytic: Living on dead or decaying organic matter.
Scale: A scale insect; a member of the order Homoptera.
Scape: The 1st antennal segment, especially if it is longer than the other segment.
Scarabaeiform: A grub like larva having a thick, soft body with a well-developed head and strong thoracic legs but with no legs on the hind region: often permanently curved into a C. The larvae of the lamellicorn beetles are of this type.
Sclerite: Any of the individual hardened plates which make up the exoskeleton.
Sclerotization: The hardening and darkening processes in the cuticle (involves the epicuticle and exocuticle with a substance called sclerotin).
Scopa: The pollen-collecting apparatus of a bee, whether it be the pollen basket on the leg or a brush of hairs on the abdomen.

Scopula: A small tuft of hairs.
Scorpion: Any member of the arachnid order Scorpionidae; they have an elongate body and a poison sting at the end of abdomen.
Scutellum: The 3rd of the major divisions of the dorsal surface of a thoracic segment: usually obvious only in the mesothorax and very large in some bugs.
Scutum: The middle of the three main divisions of the dorsal surface of a thoracic segment. Also, in ticks, the sclerotized plate covering all or most of the dorsum in males, and the anterior portion in females, nymphs, and larvae of the Ixodidae.
Sebaceous gland: A gland producing a greasy lubricating substance.
Secondary parasite: A parasite on another parasite.
Segment: One of the rings or divisions of the body, or one of the sections of a jointed limb.
Segmentation: The embryological process by which the insect body becomes divided into a series of parts or segments.
Serrate: Toothed, like a saw.
Sessile: Attached to one place and unable to move, like many female scale insects.
Seta: (pl., setae). A bristle.
Setaceous: Bristle-like, applied especially to antennae.
Simple eye: An Ocellus.
Simple metamorphosis: Metamorphosis in which the wings (when present) develop externally during the immature stage and there is no prolonged resting stage (i.e. pupa) preceding the last molt; stages included are the egg, nymphal, and adult. Also called gradual or partial metamorphosis, and paurometabolous development.
Skeletal muscle: In insects, a muscle that stretches across the body wall and serves to move one segment on another.
Social: Living in more or less organized communities of individuals.
Soldier: In termites, sterile males or females with large heads and mandibles; they function to protect the colony.
Solitary: Occurring singly or in pairs, not in colonies.
Species: The basic unit of living things, consisting of a group of individuals which all look more or less alike and which can all breed with each other to produce another generation of similar creatures.
Spermatheca: A small sac-like branch of the female reproductive tract of arthropods in which sperm may be stored.
Spermatophore: A packet of sperm.
Spine: A multicellular, thorn-like process or outgrowth of the integument not separated from it by a joint.
Spinose: Spiny.
Spiracle: One of the breathing pores - openings of the tracheal system - through which diffusion of gases takes place. They usually occur on the third thoracic segment and all the abdominal.
Spiracular Plate: A plate like sclerite next to or surrounding a spiracle.
Spittle: In insects, a frothy fluid produced by the nymphs of spittlebugs (Cercopidae).
Spur: A large and usually movable spine, normally found on the legs.
Spurious Vein: A false vein formed by a thickening of the wing membrane and usually unconnected with any of the true veins.
Squama: Any of the membranous flaps that arise near the base of the wing in many true flies (plural: squamae).
Stadium: (pl., stadia). The time interval between molts in a developing insect.
Stage: A distinct, sharply differentiated period in the development of an insect, e.g., egg stage, larval stage, pupal stage, adult stage; in mites and ticks, each instar.

Stemma: (pl., stemmata). The simple eye in holometabolous larvae. Also called lateral ocellus.
Sternite: The plate or sclerite on the underside of a body segment.
Stigma: A small coloured area near the wing-tip of dragonflies, bees, and various other clear-winged insects: also called the pterostigma.
Stomodeal Valve: In insects, the cylindrical or funnel-shaped invagination of the foregut into the midgut.
Striae: Grooves running across or along the body: applied especially to the grooves on beetle elytra.
Striated Muscle: Muscle that is composed of fibers with alternate light and dark bands.
Stridulation: The production of sounds by rubbing two parts of the body together: best known in grasshoppers and other orthopterans.
Style: A slender bristle arising at the apex of the antenna. One of the small paired appendages on the male subgenital plate of some Orthoptera.
Stylet: A needle-like object: applied to the various components of piercing mouthparts and also to a part of the sting of a bee or other hymenopteran.
Stylostome: The tube formed by the host as a result of the feeding of a chigger; in secreting salivary fluids, the chigger partially digests skin tissues, which induces the host to form a proteinaceous tube walling off the injury.
Sub-apical: Situated just before the tip or apex.
Subcosta: Usually the first of the longitudinal veins behind the front edge of the wing, although it is often missing or very faint: abbreviated to Sc.
Sub-imago: Found only among the mayflies, the sub-imago or dun is the winged insect which emerges from the nymphal skin. It is rather dull in colour, but very soon molts again - the only example of a winged insect undergoing a molt - to reveal the imago.
Sub-marginal Cells: Cells lying just behind the stigma in the hymenopteran forewing: important in the identification of bees and sphecid wasps.
Sub-species: A sub-division of a species, usually inhabiting a particular area: visibly different from other populations of the same species but still able to interbreed with them.
Superfamily: A group of closely related families; superfamily names end in -oidea.
Supplementary Reproductives: In termites the caste of males and females with short wings, light pigmentation, and small compound eyes. The females lay eggs in the colony supplementing the work of the queen.
Suture: A groove on the body surface which usually divides one plate or sclerite from the next: also the junction between the elytra of a beetle.
Synonym: One of two or more names which have been given to a single species. The earliest name usually (should) takes precedence.
Systemic Insecticide: An insecticide capable of absorption into plant sap or animal blood and lethal to insects feeding on or within the treated host.

Tarsus: (pl., tarsi). The insect's foot: primitively a single segment but consisting of several segments in most living insects.
Tegmen: (plural tegmina) The leathery forewing of a grasshopper or similar insect, such as a cockroach
Tegula: A small lobe or scale overlying the base of the forewing like a shoulder-pad.
Tergite: The primary plate or sclerite forming the dorsal surface of any body segment.
Tergum: The dorsal surface of any body segment.
Thorax: The middle of the three major divisions of the insect body. The legs and wings (if present) are always attached to the thorax.

Tibia: (pl., tibiae) The forth leg segment between the femur and the tarsus.
Totipotency: The potential, throughout life, to express the full behavioral repertoire of the population (even if never actually expressed), and the ability to produce offspring like oneself, exhibiting the full behavioral repertoire of the population, without help.
Trachea: (Plural tracheae). One of the minute tubes which permeate the insect body and carry gases to and from the various organs, etc. They open to the air at the spiracles.
Transverse Suture: A suture running across the thorax of many flies and dividing the mesonotum into a scutum and a prescutum.
Triangle: A triangular region near the base of the dragonfly wing, often divided into smaller cells.
Triungulin: Name given to the active 1st- instar larva of oil beetles and some of their relatives: they appear to have 3 claws on each foot.
Trochanter: The second segment of the leg, between coxa and femur: often very small and easily overlooked.
True legs: legs found on the thoracic segments of the larva. These legs are segmented and very different from the prolegs of the abdomen.
Truncate: Ending abruptly: squared off.
Tubercle: A small knob-like or rounded protuberance.
Tymbal: The sound-producing 'drum-skin' of a cicada.
Tympanum: The auditory membrane or ear-drum of various insects.
Type: The type specimen of a species is the actual insect from which the original description of that species was produced. If several specimens were used for this purpose, one of them should have been designated as the type. Because the type can be of only one sex, it is usual to designate a certain individual of the opposite sex as the allotype. The original type specimen is then called the holotype. These ‘type specimens' are very important in taxonomy and classification.

Uric Acid: The chief nitrogenous waste of birds, reptiles and insects-; chemically, C,H,N,O,.

Valve: One of the paired components of the ovipositor.
Veins: In insects, the rib-like tubes that strengthen the wings.
Vermiform larva: A legless worm-like larva without a well-developed head
Venation: The arrangement of veins in the wings of insects.

Ventral: Concerning the lower side of the body.
Vertex: The top of the head, between and behind the eyes.
Vestigial: Poorly developed, degenerate or atrophied, more fully functional in an earlier stage of development of the individual or species.
Visceral muscle: A muscle which invests an internal organ.
Vibrissae: The pair of large bristles just above the mouth in certain flies: usually simply called vibrissae.
Viviparous: Bringing forth living or active young instead of laying eggs

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