

# COCKROACH CONTROL

PROFESSIONAL DEVELOPMENT  
CONTINUING EDUCATION COURSE





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American Cockroach

## **Precept-Based Training Course**

This training course is based upon a form of induction training, made of topical and technical precepts. The training topics are made up of “micro-content” or “precepts”—or small chunks of information that can be easily digested. These bite-size pieces of technical information are considered to be one of the most effective ways of teaching people new information because it helps the mind retain knowledge easier. Micro-learning or precept-based training doesn’t rely on the student to process a large amount of information before breaking it down. Our method includes short modules with clearly defined learning goals for each section. This method allows a student to hone in on a particular skill, then given the opportunity to exhibit their knowledge in the final assessment.



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

**Do not solely depend on TLC’s Approval list for it may be outdated.**

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

### ***Responsibility***

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

# 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 do finish the material on your leisure. Students can also receive course materials through the mail. The CEU course or e-manual will contain all your lessons, activities and 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 can 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**

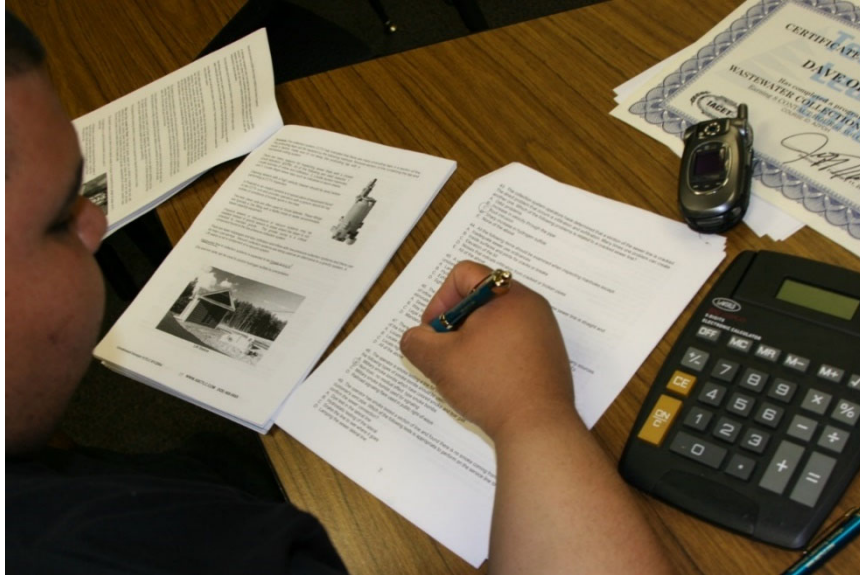
TLC's online courses combine the best of online delivery and traditional university textbooks. You can easily find the course syllabus, course content, assignments, and the post-exam (Assignment). This student friendly course design allows you the most flexibility in choosing when and where you will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

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



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

**Contact Numbers**  
**Fax (928) 468-0675**  
**Email [Info@tlch2o.com](mailto:Info@tlch2o.com)**  
**Telephone (866) 557-1746**



# Cockroach Control Distance Learning Course

## CEU Course Description

Cockroaches play an important ecological role. They are generalist feeders, capable of digesting a wide range of substances due to the variety of bacteria and protozoa in their digestive systems. They help decompose forest litter and animal fecal matter and are, in turn, food for many other animals, including scavengers of dead cockroaches, predators, and egg parasites. They are therefore an important part of the food web. The success of their survival strategies is proven by the longevity of the group and their amazing diversity.

Only about 1 percent of cockroach species are considered pests to humans and these are basically nuisance pests. Cockroaches have earned a bad reputation not only because they feed on human food stores and garbage; but, because they foul their surroundings, they leave behind a repugnant odor, and are extremely difficult to eradicate. However, cockroaches may not be as dirty as they seem. In laboratory experiments, household species are capable of contaminating food and other objects with human disease organisms, but they have not been implicated in actual disease outbreaks.

This course is intended to serve as a source of basic information needed to implement an integrated pest management program for cockroaches and to provide continuing education for the pesticide applicators. This course will review basic pesticide usage information and application methods. This course is general in nature and not state specific. You will not need any other materials for this course.

### Course Procedures for Registration and Support

All of Technical Learning College's correspondence courses have complete registration and support services offered. Delivery of services will include, e-mail, web site, telephone, fax and mail support. TLC will attempt immediate and prompt service.

When a student registers for a distance or correspondence course, he/she is assigned a start date and an end date. It is the student's responsibility to note dates for assignments and keep up with the course work. If a student falls behind, he/she must contact TLC and request an end date extension in order to complete the course. It is the prerogative of TLC to decide whether to grant the request.

All students will be tracked a unique number assigned to the student.

### Instructions for Written Assignments

The Cockroach Control CEU training course uses a multiple choice style answer key.

You can find the assignment on our webpage under the Assignment section. Please download and print it out. Simply fax it back to us when finished.



### **Feedback Mechanism (examination procedures)**

Each student will receive a feedback form as part of his or her study packet. You will be able to find this form in the front of the assignment.

### **Security and Integrity**

All students are required to do their own work. All lesson sheets and final exams are not returned to the student to discourage the sharing of answers. Any fraud or deceit and the student will forfeit all fees and the appropriate agency will be notified.

### **Grading Criteria**

TLC will offer the student either pass/fail or a standard letter grading assignment. If TLC is not notified, you will only receive a pass/fail notice.

### **Required Texts**

The course will not require any other materials. This course comes complete.

### **Environmental Terms, Abbreviations, and Acronyms**

TLC provides a glossary that defines in non-technical language commonly used environmental terms appearing in publications and materials. It also explains abbreviations and acronyms used throughout the EPA and other governmental agencies. You can find the glossary in the rear of this manual.

### **Recordkeeping and Reporting Practices**

TLC will keep all student records for a minimum of five years. It is your responsibility to give the completion certificate to the appropriate agencies.

### **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 this particular group.

**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 graded assignment or quiz results within two or three weeks after submitting it, please contact your instructor.

We expect every student to produce his/her original, independent work. Any student whose work indicates a violation of the Academic Misconduct Policy (cheating, plagiarism) can expect penalties as specified in the Student Handbook, which is available through Student Services; contact them at (928) 468-0665.

A student who registers for a Distance Learning course is assigned a "**start date**" and an "**end date**." It is the student's responsibility to note due dates for assignments and to keep up with the course work.

If a student falls behind, she/he must contact the instructor and request an extension of her/his **end date** in order to complete the course.

You will have 90 days from receipt of this manual to complete it in order to receive your Continuing Education Units (**CEUs**) or Professional Development Hours (**PDHs**).

A score of 70% is necessary to pass this course. If you should need any assistance, please email all concerns or call us. If possible e-mail the final test to info@tlch2o.com or fax (928)468-0675.

**Course Objective:** To provide training in cockroach identification, cockroach control, effective, safe pesticide applications and treatment methods.



## Pesticide Poisoning

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

## Seeking Medical Attention 1-800-222-1222

If you are having symptoms but are unsure if they are pesticide related, at least notify someone in case your symptoms become worse. But 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.

## **Important Information about this Manual**

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

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

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

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

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

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

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

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

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

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

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

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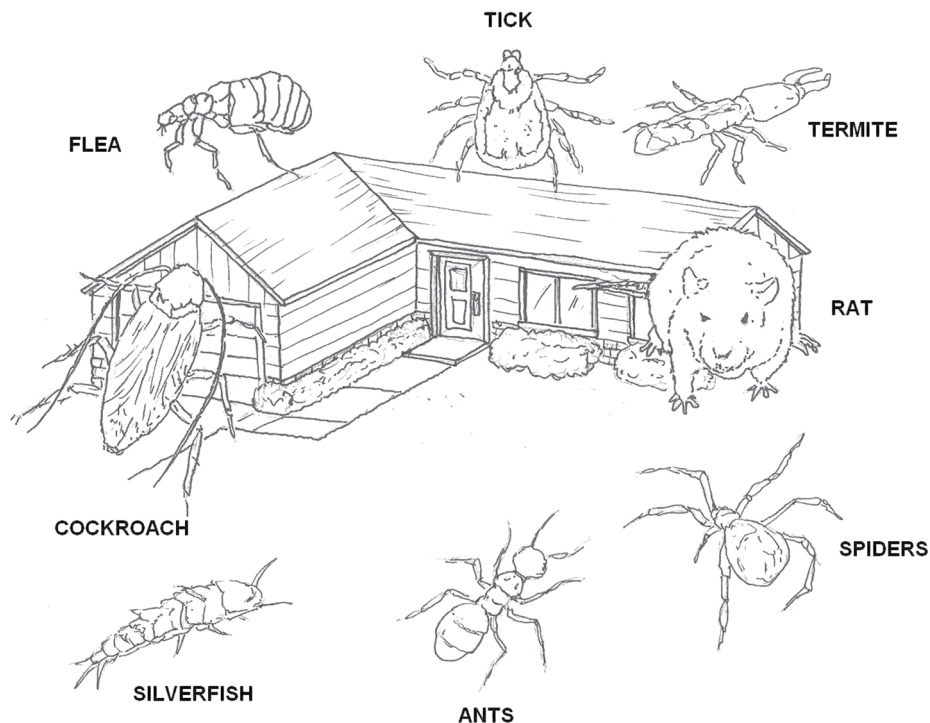




# Topic 1 - Cockroach Introduction

**Topic 1- Section Focus:** You will learn the basics of cockroaches, including the life cycle, behavior and related scientific information. At the end of this section, you the student will be able to understand and describe general information about the cockroach, including the life cycle and related information. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

**Topic 1- Scope/Background:** The humans and cockroach relationship is quite remarkable. These rapidly adapting insects have followed humans as pets from the time when our ancestors lived in caves to now when we have moved to skyscrapers. There cannot be a single home in the world which has not been shared with cockroaches. In fact, most of you must be facing these disgusting creatures on a daily basis — seeing them crawl on your sink, running down the pipe hole, lurking over a pile of garbage or resting peacefully in the corners of your refrigerator. The fact is, cockroaches come out in the daylight only when the place is too crowded for them or when they are ill.



**COMMONLY FOUND HOUSEHOLD PESTS DIAGRAM**

## Introduction

Cockroach or “roach” is the common name for an order of insects - the most familiar of which are characterized by their oval shape, foul odor, and status as household pests. About 4,000 roach species are known worldwide; most inhabit the warm tropical regions of the globe. About 25 species have attained worldwide distribution due to accidental transport in commerce and their affinity for human habitation and trash. Among these roaches are most of the important pest species that spread disease.

Cockroaches are an ancient group of insects, having changed little in appearance except in size in thousands of years. In the past, cockroaches were up to 10 times larger in size than today. Fossil records indicate that they were here from the beginning of time and will outlive humans.

Cockroaches are among the hardiest (robust; capable of enduring difficult conditions) insects on the planet. Some species are capable of remaining active for a month without food and are able to survive on limited resources like the glue from the back of postage stamps. Some can go without air for 45 minutes. In one experiment, cockroaches were able to recover from being submerged underwater for half an hour.

Cockroaches are the most important insect pests in households and public places. The cockroach is a dorso-ventrally flattened insect, meaning it looks flatter when view from the side compared to its shape when viewed from above. The head is orientated in a downward-facing position and from above is largely covered by the pronotum. These insects have chewing mouth parts, three pairs of legs and usually two pairs of wings. The two pairs of wings are differentiated with the tegmina (forewings) being leathery and serving to protect the fan-shaped hindwings, which are the primary flight wings. The wings show mainly longitudinal venation. These incredible creatures were designed with well-developed compound eyes and very long filiform antennae are found on the head.

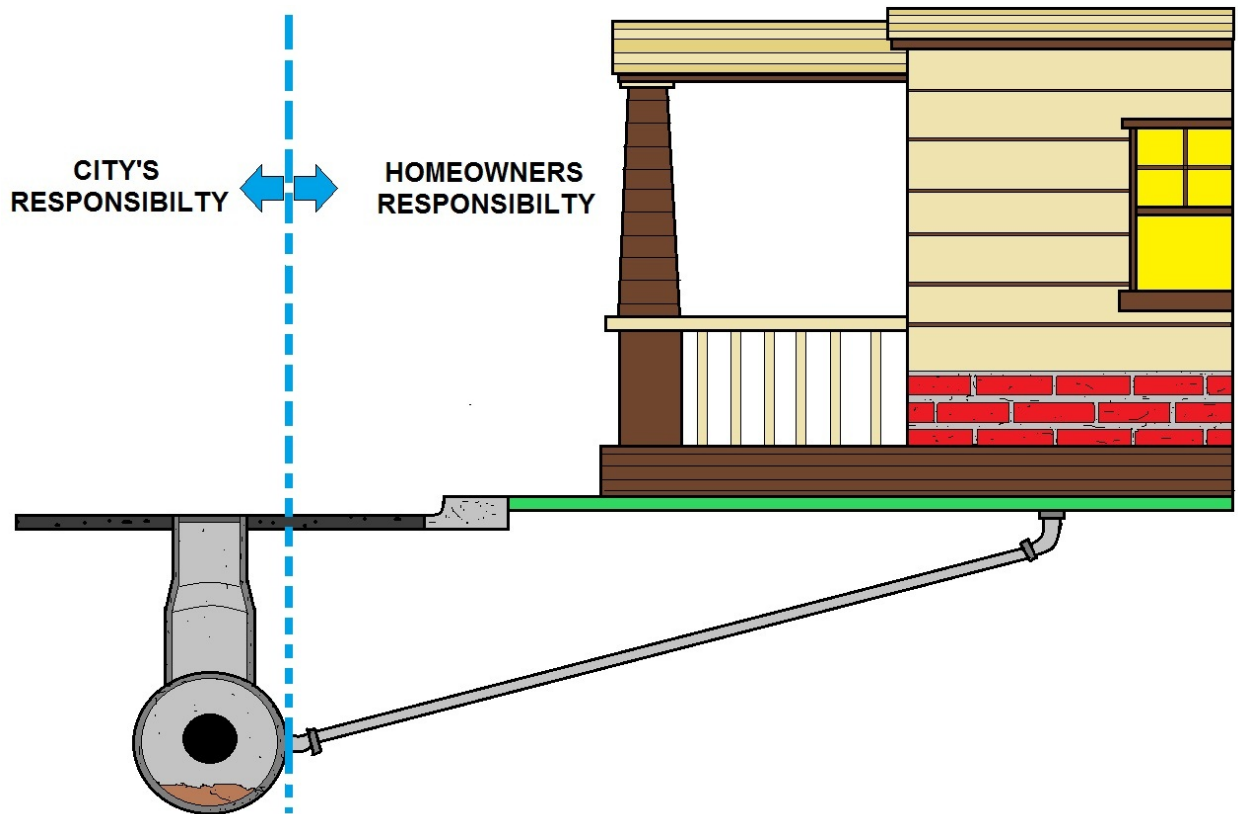
### **Hated Insect**

The cockroach is probably one of the best known and most hated of insects. Roaches are associated by most people as an indicator of filth and unhygienic conditions. This is the primary reason we need pesticide applicators. Roaches are a super intelligent insect and will outwit most of us. It will take you years to master cockroach control.

As earlier stated, some 4000 species are recognized today. Of these, only about twelve are commonly associated with humans. We will examine these later. Due to their close contact with humans, several common names have been given to these insects. The actual name cockroach is reportedly of Spanish origin, derived from the word "**Cucaracha**". We will cover these twelve in detail later in the course.

It is popularly suggested that cockroaches will "inherit the earth" if humanity destroys itself in a nuclear war. Cockroaches do indeed have a much higher radiation resistance than vertebrates, with the lethal dose perhaps 6 to 15 times that for humans. However, they are not exceptionally radiation-resistant compared to other insects, such as the fruit fly.

The cockroach's ability to withstand radiation better than human beings can be explained through the cell cycle. Cells are most vulnerable to the effects of radiation when they are dividing. A cockroach's cells divide only once each time it molts, which is weekly at most in a juvenile roach. Since not all cockroaches would be molting at the same time, many would be unaffected by an acute burst of radiation, but lingering radioactive fallout would still be harmful



## DESIGNATING SEWER MAINTENANCE RESPONSIBILITY

**Most municipalities will have the collections (sewer) department dust the manholes and other areas that cockroaches live.**

### Background

Cockroaches live in a wide range of environments around the world. Pest species of cockroaches adapt readily to a variety of environments, but prefer warm conditions found within buildings. Many tropical species prefer even warmer environments and do not fare well in the average household. The spines on the legs were earlier considered to be sensory, but observations of their locomotion on sand and wire meshes have demonstrated that they help in locomotion on difficult terrain. The structures have been used as inspiration for robotic legs.

Cockroaches leave chemical trails in their feces as well as emitting airborne pheromones for swarming and mating. These chemical trails transmit bacteria on surfaces. Other cockroaches will follow these trails to discover sources of food and water, and also discover where other cockroaches are hiding. Thus, cockroaches can exhibit emergent behavior, in which group or swarm behavior emerges from a simple set of individual interactions.

Daily rhythms may also be regulated by a complex set of hormonal controls of which only a small subset have been understood. In 2005, the role of one of these proteins, Pigment Dispersing Factor, was isolated and found to be a key mediator in the circadian rhythms of the cockroach.

Research has shown that group-based decision-making is responsible for complex behavior such as resource allocation. In a study where 50 cockroaches were placed in a dish with three shelters with a capacity for 40 insects in each, the insects arranged themselves in two shelters with 25 insects in each, leaving the third shelter empty. When the capacity of the shelters was increased to more than 50 insects per shelter, all of the cockroaches arranged themselves in one shelter. Researchers found a balance between cooperation and competition exists in the group decision-making behavior found in cockroaches. The models used in this research can also explain the group dynamics of other insects and animals.

### **Live Everywhere**

Characteristically, most roaches hide in cracks and crevices or between surfaces that provide darkness and cover. Inside buildings, roaches move freely between rooms or adjoining apartments using wall spaces, plumbing and other utility installations. They can be carried into structures in food and beverage boxes, grocery sacks, animal food and other household goods.

Cockroaches can eat almost anything, but they are especially partial to starchy foods and meat products. They feed on such diverse items as cereals, pastries, chocolate, milk products, beverages, cooked potatoes, glue, book bindings, wall paper, animal food, fresh or dried blood, excrement, dead animals and leather products. We will cover this area again in the Inspection and Management Sections.

### **Nocturnal**

Cockroaches are mainly nocturnal and will run away when exposed to light. A peculiar exception is the Asian cockroach, which is attracted to light. Another study tested the hypothesis that cockroaches use just two pieces of information to decide where to go under those conditions: how dark it is and how many other cockroaches there are.

The study conducted by José Halloy and colleagues at the Free University of Brussels and other European institutions created a set of tiny robots that appear to the roaches as other roaches and can thus alter the roaches' perception of critical mass. The robots were also specially scented so that they would be accepted by the real roaches.

Additionally, researchers at Tohoku University engaged in a classical conditioning experiment with cockroaches and discovered that the insects were able to associate the scent of vanilla and peppermint with a sugar treat.

### **Cockroaches Verses Beetles**

Some homeowners confuse cockroaches with beetles, but adult cockroaches have membranous wings and lack the thick, hardened forewings (elytra) of beetles. Roaches are nocturnal and have a tendency to scatter when disturbed. Immature cockroaches (nymphs) look like adults, but are smaller and do not have wings.

## **Cockroach Facts**

- Roaches can survive without food for up to a month.
- Roaches are repulsed by humans and will wash themselves if contact with a human.
- A cockroach can live underwater for up to 30 minutes and can hold its breath for as long as 40 minutes.
- Roaches milk is 3 times more nutritious as human milk. Think about that one for a minute.
- A roach can live without its head for an entire week. The only reason a roach will die is that it can't drink without a head and needs moisture to survive.
- Roaches can travel at speeds of up to three miles an hour, so they can easily make it from one part of a home to another.
- A cockroach that is only one-day old can run almost as quickly as its parents. Since these creatures are only about the size of a speck of dust at that point, you are unlikely to see them.

## **Common Cockroach Related Diseases**

Cockroaches can carry disease-causing bacteria, spreading salmonella, dysentery, gastroenteritis and diarrhea among others. The organisms causing these diseases are carried on the legs and bodies of cockroaches, and are deposited on food and utensils as cockroaches feed and move about.

## **Cockroaches are Arthropods (Lobsters to Spiders)**

Cockroaches are arthropods having jointed appendages, an exoskeleton (hard, external covering made mostly of chitin), segmented body, ventral nervous system, open circulatory system, digestive system, and specialized sensory receptors.

## **Cockroaches are True Insects**

Cockroaches are classified as "true insects" (that is, species classified in the Class Insecta). True insects are distinguished from all other arthropods in part by having ectognathous, or exposed, mouthparts. They are sometimes termed Ectognatha, which is synonymous with Insecta. We will cover this area in better detail in a few more pages.

## **Cockroaches are Generally Lazy Creatures**

Cockroaches can move quite quickly only when necessary, and can run as fast as three miles per hour. Even a one-day-old baby cockroach can run almost as fast as a grown-up one. However, roaches only move quickly when they detect danger. The rest of the time, they are lazy. A cockroach spends approximately three-quarters of its time just resting in one spot. Roaches that live near humans spend most of their time hiding in dark, wet, secluded places. They can happily survive and reproduce in just a few inches of space.

## **Cockroaches may Fly - Others are Unable to Fly**

Cockroaches rely on their feet more than their wings when trying to get away from predators. Although many species have wings, most cockroaches can only fly over a short distance. Some species of cockroaches cannot fly at all. American cockroaches, for example, only use their wings to glide from a high spot to a lower surface. The wings of the roaches are often quite tough and sturdy, so they also act as a shield. But the tough wings, coupled with a relatively heavy body mass, make it difficult for roaches to fly efficiently.

## **Limit Water Access to Cockroaches**

Any areas of standing water will attract roaches, including water bowls for pets and puddles on bathroom or kitchen floors. These should usually be emptied each evening, and any dripping

faucets should be fixed. Some people go so far as to seal their faucets and drain pipes, particularly in older buildings that are more prone to leaks.

### **Distribution and Habitat**

Cockroaches are abundant throughout the world and live in a wide range of environments, from the tropics and subtropics. Cockroaches can withstand extremely cold temperatures, allowing them to live in the Arctic.

Some species are capable of surviving temperatures of -188 °F by manufacturing an insect type of antifreeze made out of glycerol.

Cockroaches occupy a wide range of habitats. Many live in leaf litter, among the stems of matted vegetation, in rotting wood, in holes in stumps, in cavities under bark, under log piles and among debris.

Some roaches live in arid regions and have developed mechanisms to survive without access to water sources. Other types of roaches live in the forest canopy where they may be one of the main types of invertebrate present. Here they may hide during the day in crevices, among dead leaves, in bird and insect nests or among epiphytes, emerging at night to feed.

### **Aquatic Cockroach**

Some cockroaches are aquatic, living near the surface of water bodies, including bromeliad phytotelmata, and diving to forage for food. Most of these highly designed creatures respire by piercing the water surface with the tip of the abdomen which acts as a snorkel, but some carry a bubble of air under their thoracic shield when they submerge.

### **Necessary to Fix all Leaks**

A slow drip underneath a counter or washing machine may not be problematic on a day-to-day basis, but the moist environment it creates might be just enough to encourage a roach to settle in and build a family.

### **Habitations of the Primary Found Cockroaches**

Of the six common pest species, German and brownbanded cockroaches inhabit buildings, whereas the oriental, smokybrown, American, and Turkestan cockroaches usually live outdoors or in masonry enclosures away from buildings, only occasionally invading buildings themselves. It is important to correctly identify the species involved in a cockroach infestation so that the most effective control method(s) may be chosen.

### **Natural Enemies of Cockroaches**

There are numerous parasites and predators of cockroaches, but few of them have proven to be highly effective for biological control. Wasps in the family Evaniidae are perhaps the most effective insect predators, as they attack the egg cases. Wasps in the family Ampulicidae are predators on adult and nymphal cockroaches (e.g., *Ampulex compressa*). The house centipede, is probably the most effective control agent of cockroaches, though most homeowners find the centipedes themselves objectionable.

### **Collective Decision-Making**

Sociable cockroaches often display collective decision-making when choosing food sources. When a sufficient number of individuals (a "quorum") exploits a food source, this signals to newcomer cockroaches that they should stay there longer rather than leave for elsewhere. Cooperation and competition are balanced in cockroach group decision-making behavior.

Cockroaches appear to use just two pieces of information to decide where to go, namely how dark it is and how many other cockroaches there are. A study used specially-scented roach-sized robots that appear to the roaches as real to demonstrate that once there are enough insects in a place to form a critical mass, the roaches accepted the collective decision on where to hide, even if this was an unusually light place. Use this information for proper bait or trap placement. These highly designed creatures will adapt and out think you in common treatments.

### **Social Behavior**

Sociable German cockroaches show different behavior when reared in isolation from when reared in a group. In one study, isolated cockroaches were less likely to leave their shelters and explore, spent less time eating, interacted less with other cockroaches when exposed to them, and took longer to recognize receptive females. Because these changes occurred in many contexts, some have suggested this action as constituting a behavioral syndrome. These effects might have been due either to reduced metabolic and developmental rates in isolated individuals or the fact that the isolated individuals hadn't had a training period to learn about what others were like via their antennae.

Individual American cockroaches appear to have consistently different "personalities" regarding how they seek shelter. In addition, group personality is not simply the sum of individual choices, but reflects conformity and collective decision-making. The gregarious German and American cockroaches have elaborate social structure, chemical signaling, and "social herd" characteristics. Lihoreau and his fellow researchers stated: "*The social biology of domiciliary cockroaches ... can be characterized by a common shelter, overlapping generations, non-closure of groups, equal reproductive potential of group members, an absence of task specialization, high levels of social dependence, central place foraging, social information transfer, kin recognition, and a meta-population structure*".

### **Cockroaches Sleep**

Cockroaches have activity rhythms, i.e. regular times in the day when they are quiet and hide away from the rest of the world as well as wakeful times when they are active, seeking food, water and a mate. In general, most pest species of cockroaches are active (i.e. awake) during the four hours after lights-out. That is why they are often visible when you go to the refrigerator for that midnight snack or come home late from the movies.

Roaches cue on that time when you normally shut off all the lights and go to bed. That ensuing four hours of activity is enough for them to get all their important business done without the high probability of running into you. In a study, one four-hour stretch of food availability was enough to get them through an entire molting cycle of about 6 days. In a high density cockroach infestation, the population may be forced to come out at other times to find food.

If you have lowered the population down by using insecticides and management strategies, whether that is a commercial insecticide or your boric acid application, the remaining few cockroaches will be satisfied with the four-hour stretch after lights-out and you will rarely see them. While we sleep they are active; while they sleep we are active.



### **Crazy Customer World**

Nothing more ironic than spraying a home for roaches and having the homeowner raising giant hissing cockroaches as pets. The little cockroaches are pests but the big ones are pets, like a dog.

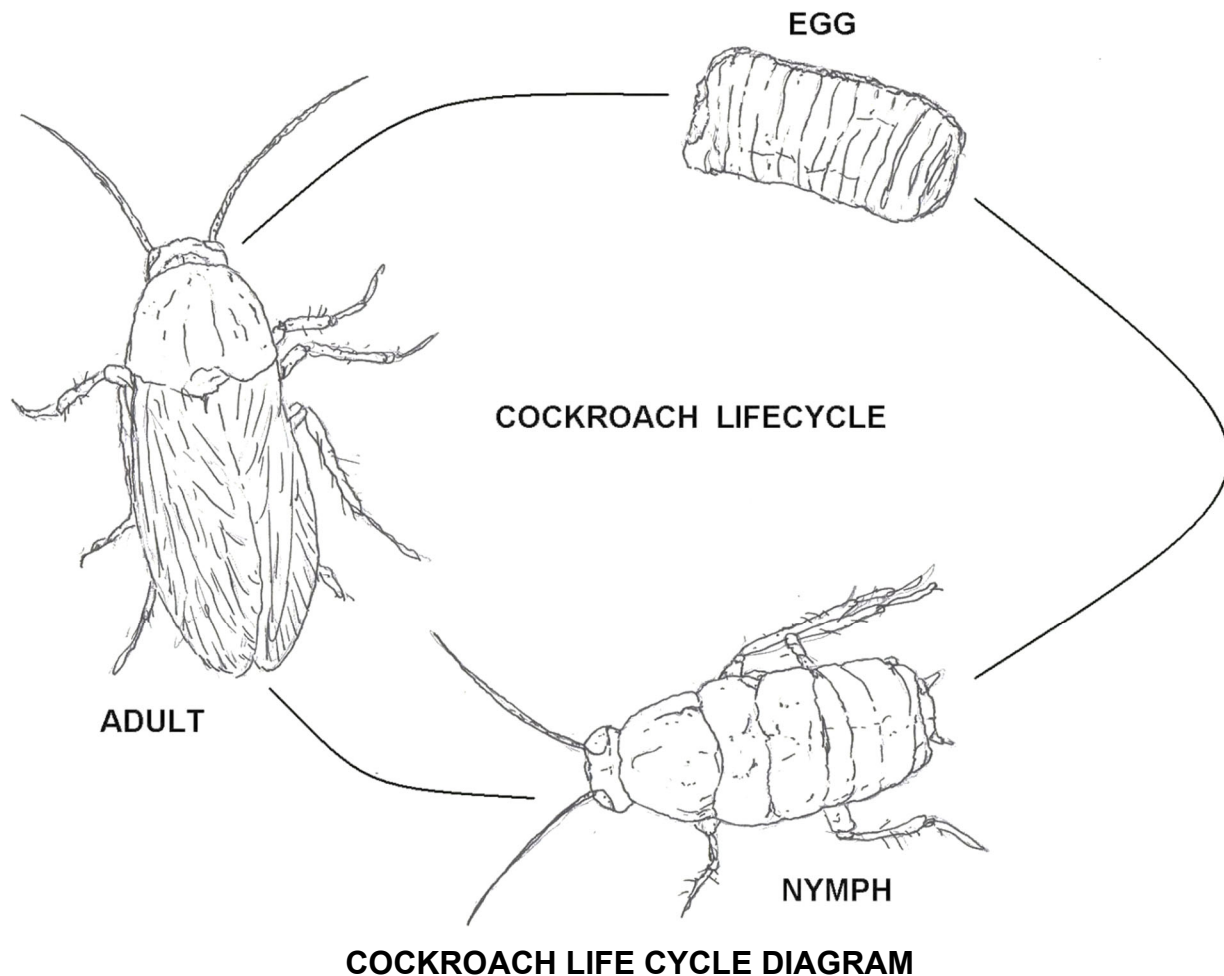
How about finding a restaurant filled with cockroaches and both the insect type and seeing the large seafood type of roach-like lobster being served hot to human customers? Just another day for an applicator.



## Cockroach Life Cycle

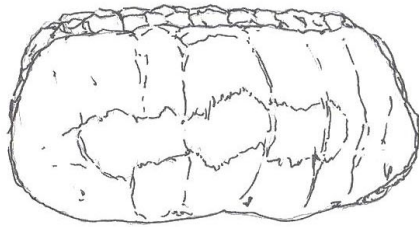
All roaches have three stages in their life cycle -- egg, nymph (young) and adult. Some have live birth and others lay eggs.

Females carry a bean-shaped egg capsule (ootheca) which is full of eggs. The newly emerged nymphs are identical to their parents except for their smaller size and lack of wings. The nymphs grow into adults by periodically shedding their skins, and may appear white for a few hours until their new skin darkens.

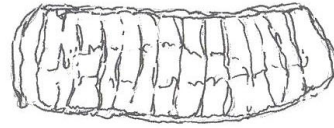


### Reproduction

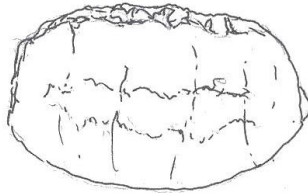
Cockroaches use pheromones to attract mates, and the males practice courtship rituals, such as posturing and stridulation. Like many insects, cockroaches mate facing away from each other with their genitalia in contact, and copulation can be prolonged. A very few cockroach species are known to be parthenogenetic, reproducing without the need for males.



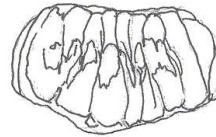
AMERICAN COCKROACH



GERMAN COCKROACH



ORIENTAL COCKROACH



BROWN BANDED COCKROACH

### COCKROACH EGG TYPES DIAGRAM

## Stridulation

Stridulation is the act of producing sound by rubbing together certain body parts. This behavior is mostly associated with insects, but other animals are known to do this as well, such as a number of species of fish, snakes and spiders. The mechanism is typically that of one structure with a well-defined lip, ridge, or nodules (the "scraper" or **plectrum**) being moved across a finely-ridged surface (the "file" or **stridulitrum**—sometimes called the **pars stridens**) or vice versa, and vibrating as it does so, like the dragging of a phonograph needle across a vinyl record. Sometimes it is the structure bearing the file which resonates to produce the sound, but in other cases it is the structure bearing the scraper, with both variants possible in related groups. Common onomatopoeic words for the sounds produced by stridulation include **chirp** and **chirrup**.

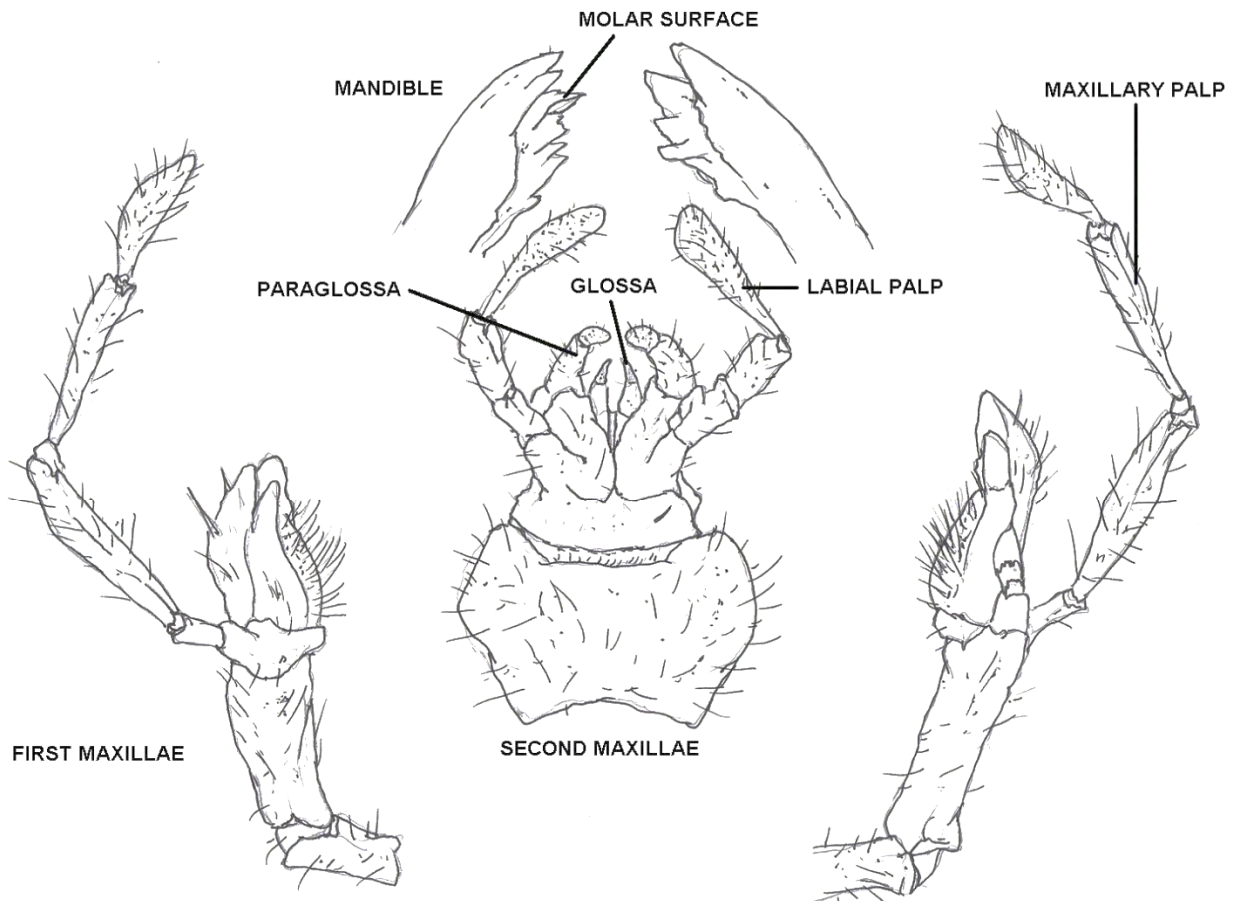
Female cockroaches are sometimes seen carrying egg cases on the end of their abdomens; the German cockroach holds about 30 to 40 long, thin eggs in a case called an ootheca. She drops the capsule prior to hatching, though live births do occur in rare instances. The egg capsule may take more than five hours to lay and is initially bright white in color. The eggs are hatched from the combined pressure of the hatchlings gulping air.

The hatchlings are initially bright white nymphs and continue inflating themselves with air, becoming harder and darker within about four hours. Their transient white stage while hatching and later while molting has led to claims of albino cockroaches.

Development from eggs to adults takes three to four months. Cockroaches live up to a year, and the female may produce up to eight egg cases in a lifetime; in favorable conditions, she can produce 300 to 400 offspring. Other species of cockroaches, however, can produce far more eggs; in some cases, a female needs to be impregnated only once to be able to lay eggs for the rest of her life.

The female usually attaches the egg case to a substrate, inserts it into a suitably protective crevice, or carries it about until just before the eggs hatch. Some species, however, are ovoviviparous, keeping the eggs inside their body, with or without an egg case, until they hatch. At least one genus, *Diploptera*, is fully viviparous.

Cockroaches have incomplete metamorphosis, meaning that the nymphs are generally similar to the adults, except for undeveloped wings and genitalia. Development is generally slow, and may take a few months to over a year. The adults are also long-lived, and have survived for as much as four years in the laboratory.



**AMERICAN COCKROACH MOUTHPARTS  
(PERIPLANETA AMERICANA)**

## Damage

**Disease Transmission.** Cockroaches can carry organisms that cause human diseases, including food poisoning, dysentery and diarrhea. However, roaches have not been associated with serious disease outbreaks in the United States.

**Repulsive Odor.** Most cockroaches produce a secretion or chemical that has a repulsive odor. This characteristic odor can be detected in infested areas.

### Allergy

Roaches can cause allergic reactions in some people. The response is caused by roach "**allergen**" that is ingested with contaminated food or inhaled when dried fecal particles and fragments of ground-up bodies of dead roaches are mixed with house dust.

### Anxiety

The sight of cockroaches can cause considerable psychological or emotional distress in some individuals. Cockroaches usually do not bite, but their heavy leg spines may scratch.

### Albino Cockroach

During ecdysis (the shedding of an arthropod's old cuticle) a cockroach's new cuticle is creamy white. This has resulted in many claims by novices of having discovered an albino cockroach. But the hour long ecdysial process ends with the tanning (darkening and hardening) of the new cuticle and, sadly, the 'extinction' of the 'albino' cockroach.

## **Cockroach Behavior Patterns**

Cockroaches like humans are social insects; a large number of species are either gregarious or inclined to aggregate, and a slightly smaller number exhibit parental care for their youth.

Some scientists used to think that cockroaches aggregated because they were reacting to environmental cues, but it is now believed that pheromones are involved in these behaviors. Some species secrete these in their feces (easily found during your inspection) with gut microbial symbionts being involved, while others use glands located on their mandibles.

Pheromones produced by the cuticle enable various cockroaches to distinguish between different populations of cockroach by odor. These behaviors involved have only been studied in a few species, but German cockroaches leave fecal trails with an odor gradient. You as an applicator will learn more about cockroaches than most scientists, for you need to master cockroach control or management in a variety of situations.

Other cockroaches follow such trails to discover sources of food and water, and where other cockroaches are hiding. Thus, cockroaches have emergent behavior and patterns, in which group or swarm behavior emerges from a simple set of individual interactions.

Daily rhythms may also be regulated by a complex set of hormonal controls of which only a small subset have been understood.

In 2005, the role of one of these proteins, pigment dispersing factor (PDF), was isolated and found to be a key mediator in the circadian rhythms of the cockroach.

Pest species adapt readily to a variety of environments, but prefer warm-wet conditions found within buildings. Many tropical species prefer even warmer environments. Cockroaches are mainly nocturnal and run away when exposed to light. An exception to this is the Asian cockroach, which flies mostly at night but is attracted to brightly lit surfaces and pale colors. We will cover more on this subject later.

### **Cockroach Bite**

The cockroach is an omnivore, that is, it eats everything edible, animal and vegetable. So if we do not move around too much while sleeping they might be inclined to nibble on our earlobes at night. They are rarely aggressive enough to attack us while we are awake.

### **Sounds**

Some cockroach species make a hissing noise while other cockroaches make a chirping noise, similar to a bird or squirrel. Most applicators are unable to hear these sounds. The Madagascar hissing cockroach (a common pet) produces its sound through the modified spiracles on the fourth abdominal segment. Several different hisses are produced, including disturbance sounds, produced by adults and larger nymphs, and aggressive, courtship and copulatory sounds produced by adult males.

*Henschoutedenia epilamproides* has a stridulatory organ between its thorax and abdomen, but the purpose of the sound produced is unclear.

### **Cockroach Die on their Backs**

Very few cockroaches die on their backs in the wild. Natural death of cockroaches probably occurs in the stomach of a bird, bat or other small animal. Second, Cockroaches are not used to living on a polished marble or vinyl floor. They are more used to a ruguous living plane including leaves and sticks and other vegetable debris. Thus when a cockroach finds itself on its back (by some mistake in its orienteering) it may have trouble righting itself if there is not debris around to grab hold of with its legs. (Try it, put a cockroach on its back on a polished floor with and without some crinkled paper.)

Third, often we come across dead cockroaches in buildings that have died of insecticide. Most of these insecticides are organophosphate nerve poisons. The nerve poison often inhibits cholinesterase, an enzyme that breaks down acetyl choline (ACh), a neurotransmitter. With extra ACh in the nervous system, the cockroach has muscular spasms which often result in the cockroach flipping on its back. Without muscular coordination the cockroach cannot right itself and eventually dies in its upside down-position.

### **Hardiness**

Cockroaches are among the hardiest insects. Some species are capable of remaining active for a month without food and are able to survive on limited resources, such as the glue from the back of postage stamps. Some can go without air for 45 minutes. Japanese cockroach (*Periplaneta japonica*) nymphs, which hibernate in cold winters, survived twelve hours at 42 °F in laboratory experiments.

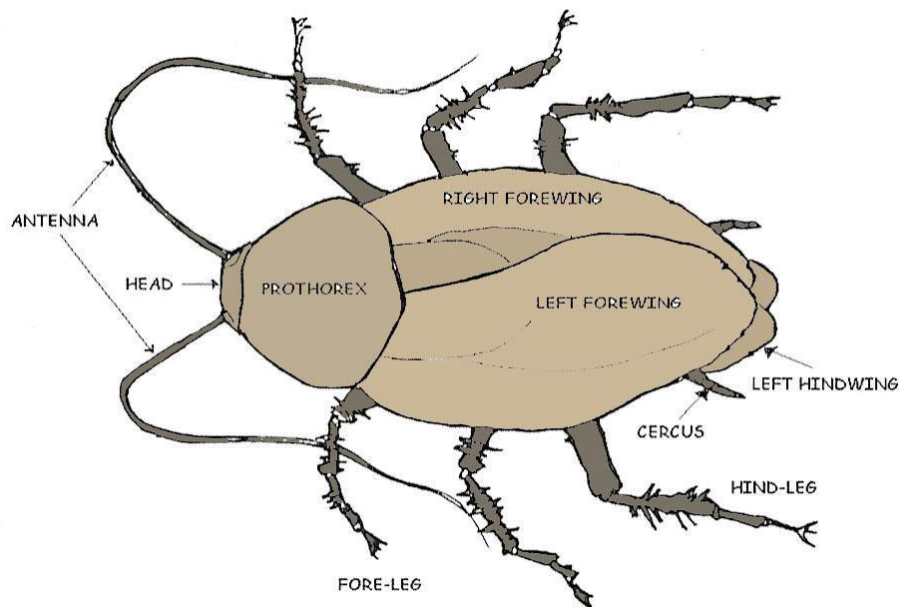
Experiments on decapitated specimens of several species of cockroach found a variety of behavioral functionality remained, including shock avoidance and escape behavior, although many insects other than cockroaches are also able to survive decapitation, and popular claims of the longevity of headless cockroaches do not appear to be based on published research.

Incredibly, the severed head is able to survive and wave its antennae for several hours, or longer when refrigerated and given nutrients.

It is popularly suggested that cockroaches will "inherit the earth" if humanity destroys itself in a nuclear war. Cockroaches do indeed have a much higher radiation resistance than vertebrates, with the lethal dose perhaps six to 15 times that for humans. However, they are not exceptionally radiation-resistant compared to other insects, such as the fruit fly.

The cockroach's ability to withstand radiation better than human beings can be explained through the design of the cell cycle. Cells are most vulnerable to the effects of radiation when they are dividing.

A cockroach's cells divide only once each time it molts, which is weekly at most in a juvenile roach. Since not all cockroaches would be molting at the same time, many would be unaffected by an acute burst of radiation, although lingering radioactive fallout would still be harmful.



**COCKROACH ANATOMY DIAGRAM #1**

### **Cockroach Digestive Tract**

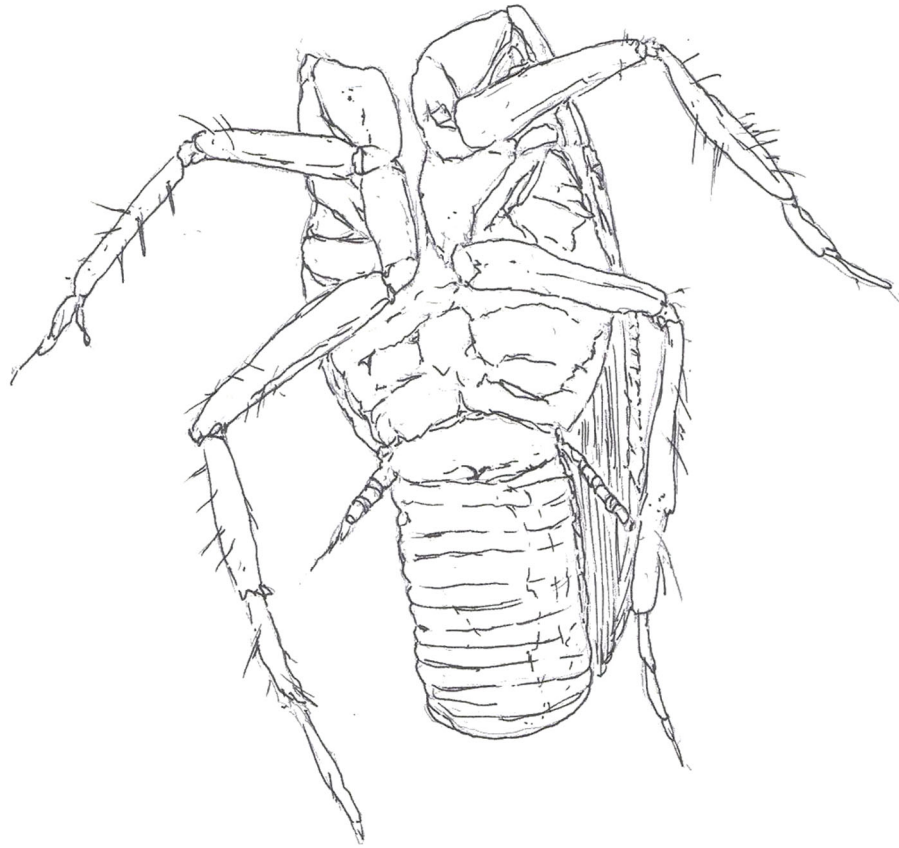
Cockroaches are generally omnivorous; the American cockroach (*Periplaneta americana*), for example, feeds on a great variety of foodstuffs including bread, fruit, leather, starch in book bindings, paper, glue, skin flakes, fingernails, hair, dead insects and soiled clothing. Many species of cockroach harbor symbiotic protozoans and bacteria in their gut which are able to digest cellulose. Since this is a symbiotic relationship, this with other design issues proves a designer.

In many species, these symbionts may be essential if the insect is to utilize cellulose; however, some species secrete cellulase in their saliva, and the wood-eating cockroach, *Panesthia cribrata*, is able to survive indefinitely on a diet of crystallized cellulose while being free of microorganisms.

Cockroaches are most common in tropical and subtropical climates. Some species are in close association with human dwellings and widely found around garbage or in the kitchen. Cockroaches are generally omnivorous with the exception of the wood-eating species such as *Cryptocercus*; these roaches are incapable of digesting cellulose themselves, but have symbiotic relationships with various protozoans and bacteria that digest the cellulose, allowing them to extract the nutrients.

The similarity of these symbionts in the genus *Cryptocercus* to those in termites are such that it has been suggested that they are more closely related to termites than to other cockroaches, and current research strongly supports this hypothesis of relationships.

All species studied so far carry the obligate mutualistic endosymbiont bacterium *Blattabacterium*, with the exception of *Nocticola australiensis*, an Australian cave dwelling species without eyes, pigment or wings, and which recent genetic studies indicates are very primitive cockroaches.



**DORSAL VIEW OF COCKROACH EGG CAPSULE**

### **Related to Termites?**

The similarity of these symbionts in the genus *Cryptocercus* to those in termites are such that these cockroaches have been suggested to be more closely related to termites than to other cockroaches, and current research strongly supports this hypothesis about their relationships.





### **Lungs and Breathing**

Cockroaches, like all insects, breathe through a system of tubes called tracheae. The tracheae of insects are attached to the spiracles, excluding the head. Thus cockroaches, like all insects, are not dependent on the mouth and windpipe to breathe. The valves open when the  $\text{CO}_2$  level in the insect rises to a high level; then the  $\text{CO}_2$  diffuses out of the tracheae to the outside and fresh  $\text{O}_2$  diffuses in. Unlike in vertebrates that depend on blood for transporting  $\text{O}_2$  and  $\text{CO}_2$ , the tracheal system brings the air directly to cells, the tracheal tubes branching continually like a tree until their finest divisions, tracheoles, are associated with each cell, allowing gaseous oxygen to dissolve in the cytoplasm lying across the fine cuticle lining of the tracheole.  $\text{CO}_2$  diffuses out of the cell into the tracheole.

While cockroaches do not have lungs and thus do not actively breathe in the vertebrate lung manner, in some very large species the body musculature may contract rhythmically to forcibly move air out and in the spiracles; this may be considered a form of breathing



## Arthropod Sub-Section

ARTHROPODS			
CHELICERATES (claw mouth)	CRUSTACEANS (hard shelled)	INSECTS (segmented)	MYRIAPODS (many feet)
			
<ul style="list-style-type: none"> <li>• FEEDING PINCERS</li> <li>• NO ANTENNAE</li> </ul>	<ul style="list-style-type: none"> <li>• SEVERAL PAIRS OF JOINTED LEGS</li> <li>• HARD PROTECTIVE OUTER SHELL</li> <li>• TWO PAIRS OF ANTENNAE</li> <li>• EYES AT THE ENDS OF STALKS</li> </ul>	<ul style="list-style-type: none"> <li>• THREE BODY PARTS</li> <li>• SIX LEGS</li> <li>• EXOSKELETON</li> <li>• TWO ANTENNAE</li> </ul>	<ul style="list-style-type: none"> <li>• HEAD AND LONG REPEATING TRUNK</li> <li>• TWO ANTENNAE</li> <li>• MANY LEGS</li> </ul>



## ARTHROPOD TYPES

Arthropods form the phylum Euarthropoda which includes insects, arachnids, myriapods, and crustaceans. The term Arthropoda as originally proposed, refers to a proposed grouping of Euarthropods and the phylum Onychophora. Arthropods range in size from the microscopic crustacean - Stygotantulus up to the Japanese giant spider crab.

Arthropods are characterized by their jointed limbs and cuticle made of chitin, often mineralized with calcium carbonate. The arthropod body plan consists of segments, each with a pair of appendages. The rigid cuticle inhibits growth, so arthropods replace it periodically by molting. Arthropods are bilaterally symmetrical and their body possesses an external skeleton. Some species have wings but roaches are not really able to fly but short distances.

Arthropods versatility has enabled them to become the most species-rich members of all ecological guilds in most environments. Arthropods have over a million described species, making up more than 80 per cent of all described living animal species, some of which, unlike most other animals, are very successful in dry environments.

### Arthropod Biology

Arthropods' primary internal cavity is a hemocoel, which accommodates their internal organs, and through which their haemolymph – analogue of blood – circulates; they have open circulatory systems. Like their exteriors, the internal organs of arthropods are generally built of repeated segments.

Their nervous system is "ladder-like", with paired ventral nerve cords running through all segments and forming paired ganglia in each segment. We will cover this section later in the course.

Their heads are formed by fusion of varying numbers of segments, and their brains are formed by fusion of the ganglia of these segments and encircle the esophagus. The respiratory and excretory systems of arthropods vary, depending as much on their environment as on the subphylum to which they belong.

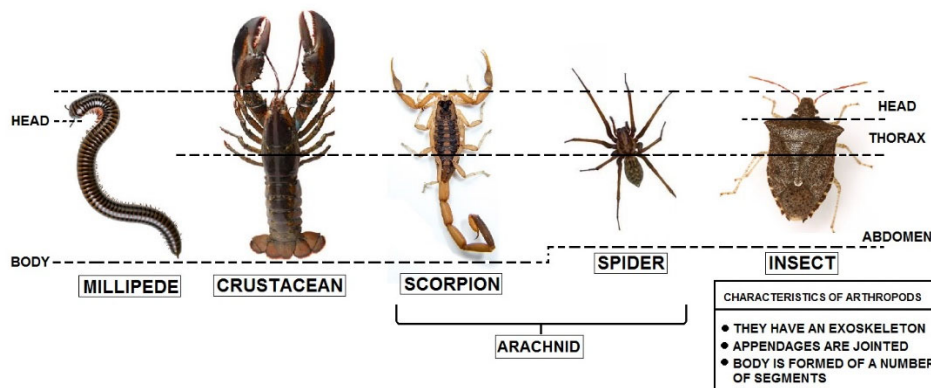
### Arthropod Vision

Arthropod vision relies on various combinations of compound eyes and pigment-pit ocelli: in most species the ocelli can only detect the direction from which light is coming, and the compound eyes are the main source of information, but the main eyes of spiders are ocelli that can form images and, in a few cases, can swivel to track prey.

### Arthropod Sensor Ability

Arthropods also have a wide range of chemical and mechanical sensors, mostly based on modifications of the many setae (bristles) that project through their cuticles. Arthropods' methods of reproduction and development are diverse; all terrestrial species use internal fertilization, but this is often by indirect transfer of the sperm via an appendage or the ground, rather than by direct injection.

Aquatic species use either internal or external fertilization. Almost all arthropods lay eggs, but scorpions give birth to live young after the eggs have hatched inside the mother. Arthropod hatchlings vary from miniature adults to grubs and caterpillars that lack jointed limbs and eventually undergo a total metamorphosis to produce the adult form. The level of maternal care for hatchlings varies from nonexistent to the prolonged care provided by scorpions.



### CHARACTERISTICS OF ARTHROPODS

The group is generally regarded as monophyletic, and many analyses support the placement of arthropods with cycloneuralians (or their constituent clades) in a superphylum Ecdysozoa.

Arthropods contribute to the human food supply both directly as food, and more importantly indirectly as pollinators of crops. Some species like cockroaches are known to spread severe disease to humans, livestock, and crops.

## Cockroach - Insect Family Introduction

### True bugs

- ✓ The true water bugs (Nepomorpha), including such insects as giant water bugs, creeping water bugs and backswimmers
- ✓ Various other true bugs insects known collectively as water bugs
- ✓ Heteroptera

Or

### Cockroaches

#### Classification of the Blattaria

- ✓ Family Cryptoceridae -- brown-hooded cockroach.
- ✓ Family Blattidae -- oriental, American, and other cockroaches.
- ✓ Family Polyphagidae -- sand cockroaches and others.
- ✓ Family Blattellidae -- German, brown-banded, and wood cockroaches.
- ✓ Family Blaberidae -- Surinam cockroach and others.

### Scientific Information

#### Gerromorpha

Gerromorpha is an infraorder of insects in the "true bug" order Hemiptera. These "typical" bugs (suborder Heteroptera) are commonly called semiaquatic bugs or shore-inhabiting bugs. The Ochteroidea of the true water bugs (infraorder Nepomorpha, a far more advanced lineage are also found in shore habitat, while Gerromorpha are actually most often encountered running around on the water surface, being kept from sinking by surface tension and their water-repellent legs. Well-known members of the Gerromorpha are the namesake Gerridae (water striders).

#### Nepomorpha

Nepomorpha is an infraorder of insects in the "true bug" order (Hemiptera). They belong to the "typical" bugs of the suborder Heteroptera. Due to their aquatic habits, these animals are known as true water bugs. They occur all over the world outside the polar regions, with about 2,000 species altogether. The Nepomorpha can be distinguished from related Heteroptera by their missing or vestigial ocelli. Also, as referred to by the obsolete name Cryptocerata ("the hidden-horned ones"), their antennae are reduced, with weak muscles, and usually carried tucked against the head.

Most of the species within this infraorder live in freshwater habitats. The exceptions are members of the superfamily Ochteroidea, which are found along the water's edge. Many of these insects are predators of invertebrates and in some cases – like the large water scorpions (Nepidae) and giant water bugs (Belostomatidae) – even small fish and amphibians. Others are omnivores or feed on plants.

Their mouthparts form a rostrum as in all Heteroptera and most Hemiptera. With this, they pierce their foodstuffs to suck out fluids; some, like the Corixidae, are also able to chew their food to some extent, sucking up the resulting pulp. The rostrum can also be used to sting in defense; some, like the common backswimmer (*Notonecta glauca*) of the Notonectidae can easily pierce the skin of humans and deliver a wound often more painful than a bee's sting.

## **Heteroptera**

Heteroptera is a group of about 40,000 species of insects in the Hemiptera. Sometimes called "true bugs", that name more commonly refers to Hemiptera as a whole, and "typical bugs" might be used as a more unequivocal alternative since among the Hemiptera the heteropterans are most consistently and universally termed "bugs". "Heteroptera" is Greek for "different wings": most species have forewings with both membranous and hardened portions (called hemelytra); members of the primitive Enicocephalomorpha have wings that are completely membranous.

The name "Heteroptera" is used in two very different ways in modern classifications; in Linnean nomenclature it commonly appears as a suborder within the order Hemiptera, where it can be paraphyletic or monophyletic depending on its delimitation. In phylogenetic nomenclature it is used as an unranked clade within the Prosorrhyncha clade which in turn is in the Hemiptera clade. This results from the realization that the Coleorrhyncha are actually just a "living fossil" relative of the traditional Heteroptera, close enough to them to be actually united with that group.

The Gerromorpha and Nepomorpha contain most of the aquatic and semi-aquatic members of the Heteroptera, while nearly all of the remaining groups that are common and familiar are in the Cimicomorpha and Pentatomomorpha.

## **Waterbugs**

"Waterbugs" is a common name for a number of aquatic insects, most of which are classified in the infraorders Gerromorpha and Nepomorpha of the order Hemiptera. The latter infraorder contains those taxa that were once known as the "Gymnocerata". Note that the term "water bug" is very often applied to some cockroaches, which are not true bugs and as Dictyoptera not even close to them (true bugs are Paraneoptera).

### **Selected families of Water Bugs**

- ✓ Backswimmers (Notonectidae)
- ✓ Giant water bugs (Belostomatidae)
- ✓ Water scorpions (Nepidae)
- ✓ Water boatmen (Corixidae)
- ✓ Pond skaters (Gerridae)
- ✓ Smaller water strider (Veliidae)

## **Blattaria**

### **Identifying characteristics for the order Blattaria include:**

- Antennae long, filiform.
- Body usually flattened and oval.
- Head somewhat concealed from above by the pronotum.
- Legs long and slender, often spiny, adapted for running; tarsi 5 segmented.

### **Additional Information**

- ✓ Many taxonomists lump cockroaches and mantids together in the order Dictyoptera.
- ✓ Perhaps no other pairing of insects seems as unlikely as cockroaches and mantids of the order Dictyoptera. Cockroaches are almost universally reviled, while mantids, also called praying mantises, are often revered. Taxonomists rely only on physical and functional characteristics to determine groups of like insects.

Compare a cockroach and a mantid, and you'll notice both have leathery forewings. Called tegmina, these wings appear roof-shaped over the abdomen. Two pairs of legs, the middle and hind sets, appear similar - long, spiny, and made for running. The feet, or tarsi, nearly always have five segments.

Dictyopterans use chewing mouthparts to consume their food. Long segmented antennae provide mantids and cockroaches with information about their environment.

Members of this order undergo incomplete or simple metamorphosis with three stages of development: egg, nymph, and adult. The female lays eggs in groups, then encases them in foam which hardens into a protective capsule, or ootheca.

### **Habitat and Distribution**

The order Dictyoptera contains nearly 6,000 species, distributed worldwide. With very few exceptions, mantids and cockroaches require terrestrial habitats. Most species live in tropical regions.

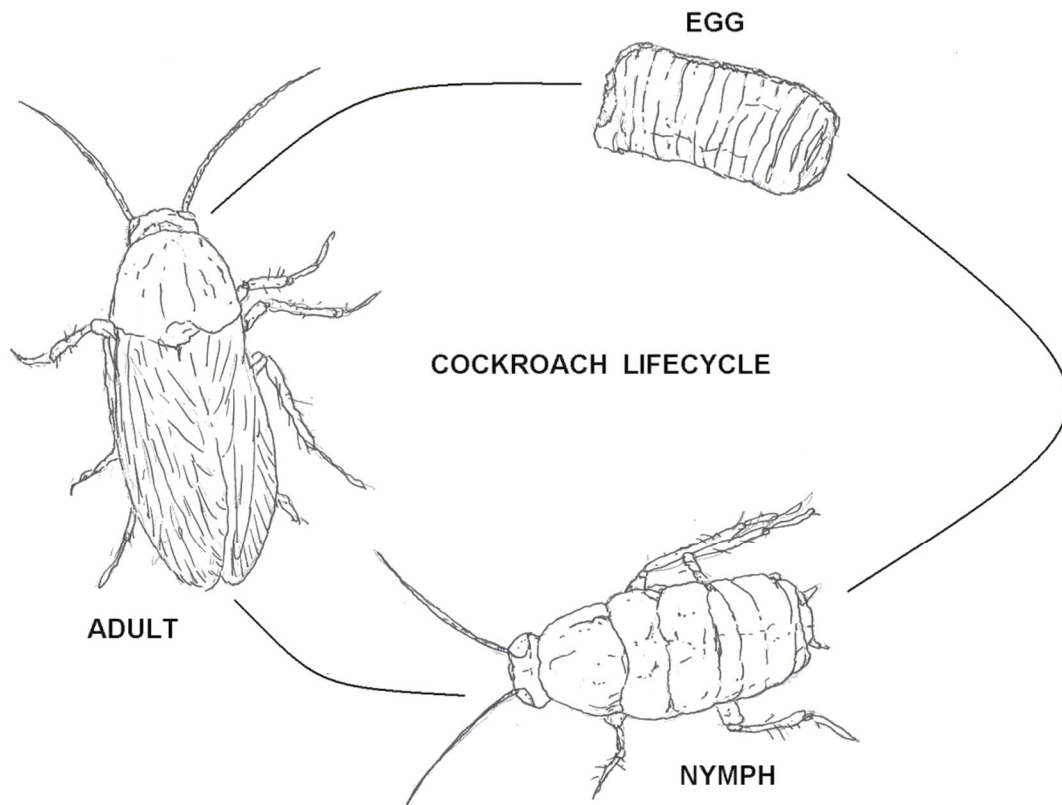
### **Major Families in the Order**

- ✓ Blattidae - Oriental and American cockroaches
- ✓ Blattellidae - German and wood cockroaches
- ✓ Polyphagidae - desert cockroaches
- ✓ Blaberidae - giant cockroaches
- ✓ Mantidae - mantids

### **Dictyopterans of Interest**

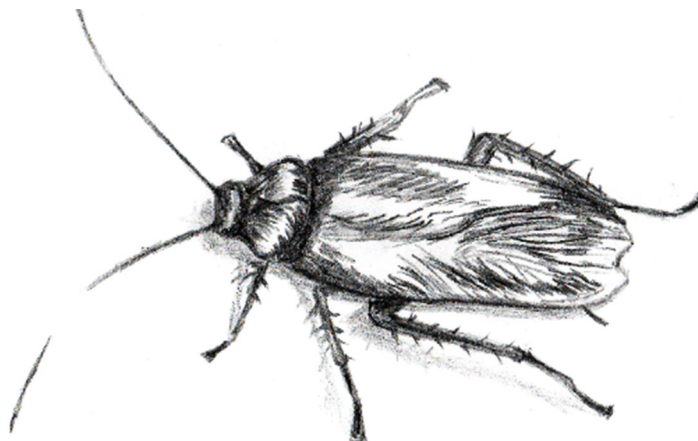
- *Blatta orientalis*, the Oriental cockroach, gains access to homes through plumbing pipes.
- The Brown-banded cockroach, *Supella longipalpa*, is called the "TV roach." It likes to hide inside warm electronic appliances.
- Brown-hooded cockroaches (*Cryptocercus punctulatus*) live in family groups. Females give birth to live young; the nymphs take 6 years to reach maturity.
- The Mediterranean mantid takes its scientific name, *Iris oratoria* from an unusual marking on the underside of its wing. Literally, the name means "talking eye," a smart description of the eyespot which is displayed when the mantid feels threatened.

Cockroaches need water as well as food, so check for condensation or leaks providing a water source. Don't forget to consider less obvious sources of water such as planters, pet water dishes and fish tanks.



## Summary of Most Commonly Found Types of Cockroaches

There are 69 species of cockroaches in North America, but only a handful infest structures. Knowing which type of cockroach is present will assist you in knowing how to proceed. We will master the proper identification of these creatures and later we will master the control of these highly designed creatures.



**AMERICAN COCKROACH**

**American Cockroach (*Periplaneta americana*)** – This is the largest cockroach commonly found within dwellings, measuring about 1 1/2 inches long when fully grown. It is reddish brown to brown, with a pale yellow band around the edge of the area behind the head. Adults have well-developed wings, but seldom fly. The nymphs are smaller and lack wings, but are otherwise similar in appearance. American cockroaches multiply more slowly than German cockroaches (although the smaller numbers tend to be offset by their size).

These cockroaches prefer dark, moist areas, such as in basements and crawl spaces. They often congregate in floor drains, sump pumps, pipe chases, and laundry areas, as well as boiler rooms, steam tunnels, and sewer systems. During warmer months, they can also be found outdoors in yards and around trash containers. American cockroaches often travel long distances from their aggregation sites; long-term relief requires finding and treating these areas.

**Brownbanded Cockroach (*Supella longipalpa*)** – This species is far less common than the German cockroach, but occasionally can be a problem in homes. Correct identification is important because it has markedly different hiding places and habits. The brownbanded cockroach is similar in size to the German cockroach, but lacks the dark lengthwise stripes on the region behind the head. Instead, there is a black bell-shaped pattern behind the head and two transverse yellowish bands across the wings.

Brown-banded cockroaches can be found anywhere in the home and are often found in rooms other than kitchens and bathrooms. Preferred locations include upper areas of ceilings, walls, cabinets, and closets; behind picture frames and wall decorations; and beneath or inside furniture. This roach attaches its pea-sized egg capsules to hidden surfaces, such as the undersides of dressers and tables.



## GERMAN COCKROACH

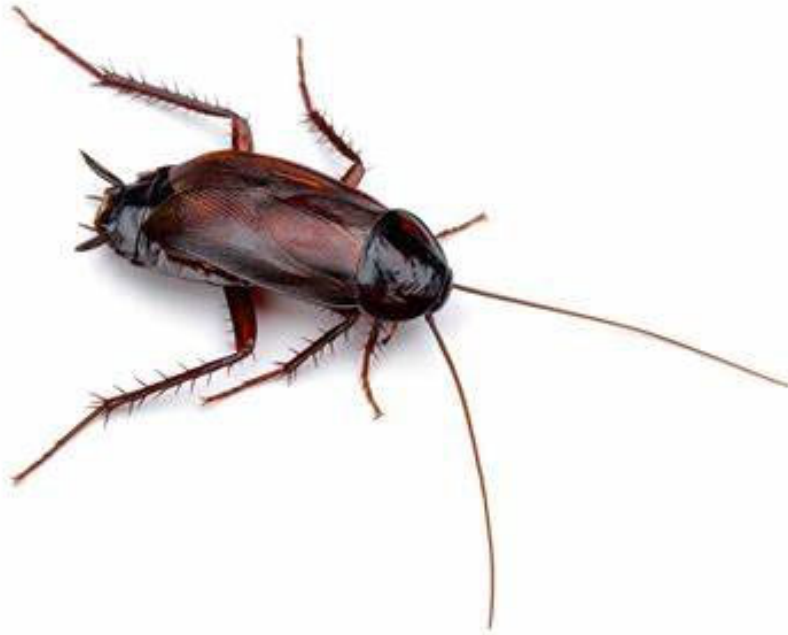
**German Cockroach (*Blattella germanica*)** – This is by far the most common cockroach infesting homes and buildings. The pest thrives in the presence of humans but does not occur outdoors. Adults are light brown and about 1/2-inch-long, with two dark stripes running lengthwise along the shield-like area behind the head. The nymphs are smaller and darker with a tan stripe down the middle of the back.

German cockroaches reproduce very rapidly, which is one reason why controlling these pests can be difficult. A single mated female can produce thousands of new cockroaches in less than a year.

German cockroaches require warmth, moisture, and food, which is why they are most common in kitchens and bathrooms. Preferred hiding places include cracks and crevices under sinks and toilets; beneath/behind refrigerators, dishwashers, and stoves; near trash containers; and inside cabinets and pantries.

German cockroaches also congregate in clocks, toaster ovens, and other heat-producing electronic equipment. When populations are large or food is scarce, they can be found in bedrooms, closets, and other areas of the home. German roaches spend most of their time hidden in cracks and crevices, but can be quite mobile. They often travel between rooms or adjoining apartments via walls, ceilings, pipes, wires and other openings.





### ORIENTAL COCKROACH

***Oriental Cockroach (Blatta orientalis)*** – The oriental cockroach is shiny black or dark brown, and the adult is about 1-inch long. The females have very short wings, and the males have wings that cover about half the abdomen. This cockroach typically infests cool, dark, damp places such as sewers, crawlspaces, cellars, and basements.

The nymphs and adults are relatively sluggish and usually occur at ground level, often living in floor drains and sump pumps. They also live outdoors under stones, debris, and plant litter, gaining entry into buildings via door thresholds, vents, and other openings. Oriental cockroaches are considered especially filthy because they often feed on garbage, human/animal waste, and decaying organic matter.

<b>Cockroach Heat Eradication Chart</b>	<b>Lethal Temperature</b>	<b>Duration Time</b>
German Adults	115° F	60 Minutes
German Adults	120° F	30 Minutes
German Adults	125° F	20 Minutes
German Adults	130° F	10 Minutes



## WOOD COCKROACH

**Wood Cockroaches (*Parcoblatta species*)** – Although the usual habitat for these cockroaches is outdoors, they often appear in homes, especially in wooded settings. The adults are about 1-inch-long and all stages are brownish in color. In some species, the outer wing margin of the adults is edged in white. Unlike the other cockroaches mentioned, male wood cockroaches are excellent fliers, and both sexes are attracted to lights.

These are primarily outdoor cockroaches, living beneath loose bark in woodpiles, fallen logs, and dead trees. They cannot survive indoors, but can be an annoyance during the spring and summer when large numbers wander in from outside. They are also brought into homes during winter in firewood. Large numbers of woods cockroaches are sometimes found nesting in rain gutters and crawl spaces.

<b>American Roach</b>	<b>German Roach</b>
<b>Scientific Classification</b>	
Kingdom: Animalia Phylum: Arthropoda Class: Insecta Order: Blattodea Family: Blattidae Genus: <i>Periplaneta</i> Species: <i>P. americana</i>	Kingdom: Animalia Phylum: Arthropoda Class: Insecta Order: Blattodea Family: Blattellidae Genus: <i>Blattella</i> Species: <i>B. germanica</i>
<b>Physical Description</b>	
They are amber colored, with a reddish-brown hue. They show the presence of a yellow plate on the back on their head that bears a mark shaped as a horizontal eight, and can grow up to 3 inches in length.	They are brownish in color, and show the presence of two vertical dark stripes on the back of their head. They can grow up to a length of 0.5 - 1 inch.
<b>Diet</b>	
They consume leaves, wood fragments, fungi, algae, smaller insects, and crumbs and scraps of human food.	They feed on almost anything, including things like toothpaste, paper, soap, leather, etc. They also scavenge on any human food that is left untended.
<b>Habitat</b>	
They prefer warm and damp outdoor habitats, with the presence of mulch. They are often found in sewers and drain pipes.	They prefer a warm and slightly damp indoor environment, and are often observed in kitchens and bathrooms.
<b>Reproduction</b>	
Females lay eggs within protective shells, called ootheca, in a warm and damp environment. These shells resemble capsules, and carry about 16-20 eggs at a time. In a single laying, a female will lay 9-10 of these oothecae. Once the eggs mature, the new off-springs, called nymphs, hatch from the shell. These nymphs undergo several instar stages before fully maturing into an adult. Every instar stage is marked by the occurrence of ecdysis (molting). This process may take 5-7 months to complete. In a year, a female produces up to 150 off-springs.	They are the fastest reproducing species. The female produces 3-6 oothecae, with each shell containing around 35 eggs. The eggs mature in the shells, inside the mother's body till 1-2 days before hatching. On expulsion of the ootheca from the female's abdomen, the nymphs hatch within 48 hours. Once hatched, they too undergo ecdysis and instar stages. It takes almost 3 months for the nymphs to mature into adults.

<b>Droppings</b>	
Their droppings are often confused with those of mice, but mice droppings show the presence of hair. The droppings of these roaches are small and blunt-ended. They also show the presence of ridges on the sides.	Their droppings are small, dark, and appear like pepper flakes. They also leave fecal stains, in the form of smears or spots, on any surface that comes in contact with it.
<b>Odor</b>	
Rising populations, lead to the production of a musty odor.	They also produce a musty smell.
<b>Ability to Fly</b>	
They can fly with ease.	They can barely fly, and are seen gliding, at best.
<b>Lifespan</b>	
1 to 2 years.	0.5 to 1 year.

## Differences Between Male and Female Cockroaches

1. The body of male cockroach is smaller than the female.
2. The abdomen of male cockroach is slender and the last segment of the abdomen is pointed.
3. The wings of male cockroach are larger than that of the females and extend beyond the abdomen.
4. The antennae of male cockroach are smaller than that of the females.
5. In the 9th sternum of abdomen a pair of small, un-jointed anal styles and in the 10th tergum of abdomen a pair of long, palp-like jointed anal cerci are present.
6. The sternum of mesothorax is not bifurcated.

## Pesticide Training Requirements and Resources

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

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

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

### Training Requirements

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

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

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

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

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

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

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

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

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

### **Handler Training**

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

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

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

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

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

## 2018 Training Requirements and Resources and Beyond

The following requirements are enforceable January 2, 2018:

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

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

### Training Requirements

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

### Worker Training 2018

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

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

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

other sources if more readily available than decontamination supplies, and as soon as possible, wash or shower with soap and water, shampoo hair, and change into clean clothes.

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



## Handler Training Information

*We will examine these citations in detail later.*

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

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

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

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

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

## Handler Checklist

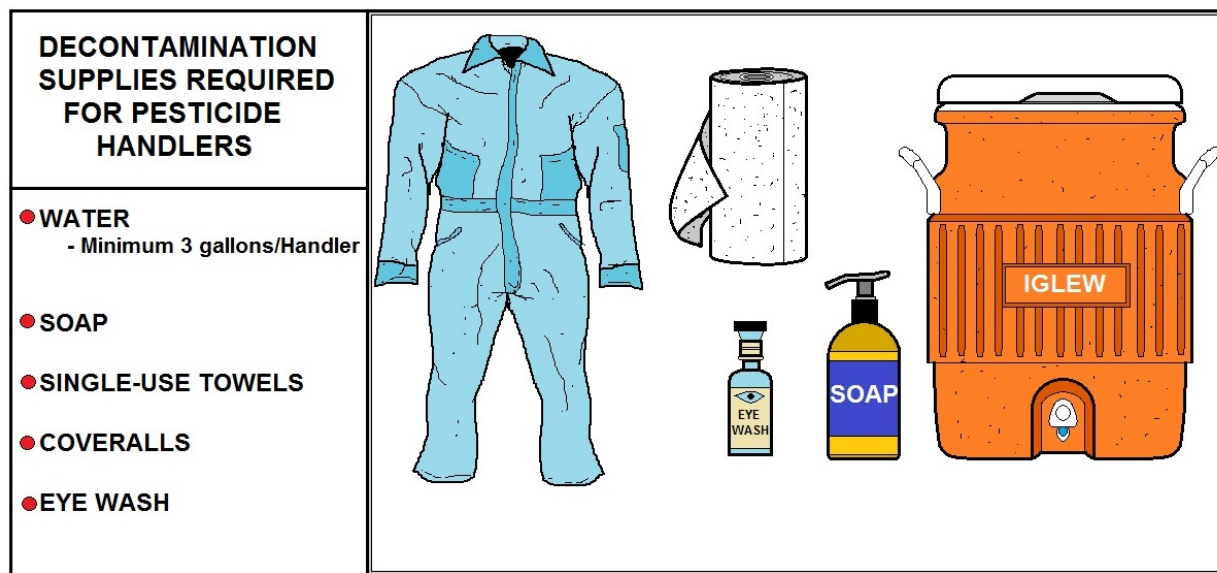
- Ensure handlers are a minimum of 18 years old.
- Complete WPS handler training before conducting handler tasks.
- Keep records of WPS handler training and provide record to handlers if requested.
- Display pesticide safety information at the central location and, if applicable, decontamination locations.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

## Pesticide Safety Training Review

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

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

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



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



## Decontamination Supply Information

1. Establish accessible decontamination supplies located together within 1/4 mile of all **workers** (when required 170.411 (c)) and **handlers**. 170.411 and 170.509
  - 1 gallon of water per worker and 3 gallons of water per handler at the beginning of each work period for routine and emergency decontamination,
  - Plenty of soap and single-use towels, Note: hand sanitizers and wet towelettes are insufficient. 170.411 (b)(2) and 170.509 (b)(2)
  - A clean coverall (or other clean change of clothes) for handlers
2. Provide water that is safe and cool enough for washing, eye-flushing, and drinking. Do not use water that is also used for mixing pesticides unless steps are taken to ensure safety. 170.411 (b)(1)
3. Provide **handlers** with decontamination supplies where personal protective equipment (PPE) is removed at the end of a task. 170.509 (a)
4. Provide **handlers** with decontamination supplies at each mixing and loading site. 170.509 (c)(1)
5. When a product requires protective eyewear for **handlers**, and/or when using a closed system under pressure, provide the following in mixing and loading areas: a system that can deliver gently running water at 0.4 gallons per minute for at least 15 minutes or 6 gallons of water in containers suitable for providing a gentle eye-flush for about 15 minutes. 170.509 (d)(1)
6. When applying a product that requires protective eyewear, provide 1 pint of water per **handler** in portable containers that are immediately available to each handler. 170.509 (d)(2)
7. Do not put **worker** decontamination supplies in areas being treated or under an REI. 170.411 (d)
8. For **handlers**, decontamination supplies must be kept outside the treated area, or any area under an REI, unless they are protected from contamination in closed containers. 170.509 (c)(1)&(3)

## Employer Information Exchange

1. Before any application, commercial pesticide handler employers must make sure the owner/operator of an agricultural establishment where a pesticide will be applied, is aware of:
  - Location and description of area to be treated,
  - Date of application, estimated start time and estimated end time of the application,
  - Product name, EPA registration number, active ingredient(s), and REI,
  - Whether the product label requires both oral warnings and treated area posting,
  - All other safety requirements on labeling for workers or other people. 170.313 (i)
2. Owners/operators of agricultural establishments must make sure any commercial pesticide handler employer they hire is aware of: Specific location and description of any treated areas where an REI is in effect that the commercial handler may be in or walk within 1/4 mile of, and,
  - Restrictions on entering those areas. 170.309 (k)
  - The commercial pesticide employer must pass this information along to the handler doing the work. 170.313 (h)

## Emergency Assistance

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

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

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

**Additional Duties for Worker Employees**

These requirements apply to agricultural employers who employ workers.

**Restrictions During Applications** 170.405 (a)-(b)

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

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

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

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

**Restricted-Entry Intervals (REIs)** 170.309 (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.



## RESTRICTED ENTRY INTERVAL (REI)

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

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

### Posted Warning Signs 170.409 (b)

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

### Oral Warnings 170.409 (c)

1. Before each application, tell workers who are on the establishment (in a manner they can understand):
  - Location and description of treated area,
  - Date and times entry is restricted
  - AEZ, REI, and not to enter during REI.
2. Workers who enter the establishment after application starts must receive the same warning at the start of their work period.

### Additional Duties for Agricultural Employers Duties

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

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

## **Application Restrictions and Monitoring 170.505**

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

### **Specific Instructions for Handlers**

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

### **Equipment Safety**

1. Inspect pesticide handling equipment before each day of use, and repair or replace as needed. 170.309 (j) and 170.313 (g)
2. Allow only appropriately trained and equipped handlers to repair, clean, or adjust pesticide equipment that contains pesticides or residues, unless they are not employed on the establishment.  
170.309 (g) and 170.507 (a) See Additional Agricultural Employer

### **Personal Protective Equipment (PPE) Handlers**






#### **Must Use**

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



## Care of PPE

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

CARTRIDGE COLOR CODE	COLOR	USED TO PROTECT AGAINST
	BLACK	ORGANIC VAPORS (PESTICIDES) and PAINT SPRAYING
	GREEN	AMMONIA: ANHYDROUS or FROM LIVESTOCK CONFINEMENT
	YELLOW	ACID GASES (i.e: HYDROGEN SULFIDE (H <sub>2</sub> S) or CARBON DIOXIDE (CO <sub>2</sub> ))
	OLIVE	ORGANIC VAPORS, AMMONIA and ACID GASES
	PINK	WELDING FUMES AND DUSTS

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

### Replacing Respirator Purifying Elements

1. Replace particulate filters or filtering facepiece respirators when any following condition is met:
  - When breathing becomes difficult,
  - When the filter is damaged or torn,
  - When the respirator label or pesticide label requires it,
  - After 8 total hours of use, in the absence of any other instructions or indications of service life. 170.507 (d)(6)
2. Replace vapor-removing cartridges/canisters when any following condition is met:
  - When odor/taste/irritation is noticed,
  - When the respirator label or pesticide label requires it (whichever is shorter),
  - When breathing resistance becomes excessive,
  - After 8 total hours of use, in the absence of any other instructions or indications of service life. 170.507 (d)(7)

## **Disposal of PPE**

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

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

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

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

*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.*

## Quick Reference Guide WPS 2017-2018 Section

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

Each section links to the Code of Federal Regulations (40 CFR Part 170) for more information on the revised WPS. ([www.ecfr.gov](http://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) and 170.601

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)



## Topic 1 - Cockroach Introduction Post Quiz

Answers in the rear near the glossary.

### True or False

1. Cockroaches leave chemical trails in their footsteps emitting airborne pheromones for swarming and mating.
2. Immature cockroaches (nymphs) look like adults, but are smaller and do not have wings.
3. Of the six common pest species, German and brownbanded cockroaches inhabit the outdoors.
4. Females carry a bean-shaped egg capsule (ootheca) which is full of eggs.
5. Development from eggs to adults takes three to four weeks.
6. Most cockroaches produce a secretion or chemical that has a pleasant odor. This characteristic odor can be detected in infested areas.
7. Arthropods also have a wide range of chemical and mechanical sensors, mostly based on modifications of the many setae (bristles) that project through their cuticles.
8. **Oriental Cockroach (*Blatta orientalis*)** – This is the largest cockroach commonly found within dwellings, measuring about 1 1/2 inches long when fully grown.
9. **American Cockroach (*Periplaneta americana*)** – This is by far the most common cockroach infesting homes and buildings.
10. **German Cockroach (*Blattella germanica*)** – This cockroach is shiny black or dark brown, and the adult is about 1-inch long.



## Topic 2 - Common Cockroach Classifications and Sub-Families

**Topic 2- Section Focus:** You will learn the cockroach scientific classification, insect order and related scientific information. At the end of this section, you the student will be able to understand and describe scientific information about the cockroach, including the arthropod family and classification. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

**Topic 2- Scope/Background:** Blattodea contains about 4000 species in at least seven families worldwide. They are hemimetabolous, dorsoventrally flattened insects with filiform, multi-segmented antennae, and mandibulate, ventrally projecting mouthparts. The prothorax has an enlarged, shield-like pronotum, often covering the head; the meso- and metathorax are rectangular and subequal. The fore wings are sclerotized as tegmina, which protect membranous hind wings folded fan-like at rest beneath the tegmina and characterized by many vein branches and a large anal lobe; wings are often reduced. Often the legs are spiny and the tarsi are 5-segmented. The abdomen has 10 visible segments, with a sub-genital plate (sternum 9), bearing in the male well-developed asymmetrical genitalia, with one or two styles, and concealing the reduced 11th segment.



**PSEUNOPHORASPIS NEBULOSA**

**Scientific classification:** Cockroaches make up the order **Blattodea**, which contains five families. The American cockroach is **Periplaneta americana**, and the Oriental cockroach is **Blatta orientalis**, both in the family Blattidae.



### **FAMILY BLABERIDAE**

#### **Blaberidae**

Giant cockroaches or blaberids (family Blaberidae) are the second largest cockroach family. Commonly these live outside and people keep these pests as pets. 11 species in 10 genera in North America.



### **Blattellidae**

The Blattellidae is a family of the order Blattaria (cockroaches). This family contains many of the smaller common household cockroaches, among others. They are sometimes called wood cockroaches. Comparing with other cockroach families, species in this family are usually smaller in size. In some species, the females are wingless. Most are active at night. There are many beautiful cockroaches in the family, however, the well-known pest - the German Cockroaches are also in this family.

- German cockroach *Blattella germanica*
- Asian cockroach *Blattella asahinai*
- Brown-banded cockroach *Supella longipalpa*
- Pennsylvania woods cockroach *Parcoblatta pennsylvanica*
- *Parcoblatta virginica*
- *Parcoblatta fulvescens*

### **Blattidae**

The Blattidae is a family of the order Blattaria (cockroaches). It contains several of the most common household cockroaches. Some species in this family are of economic importance, such as the American cockroach *Periplaneta americana* which is an introduced pest species commonly found in and around human habitation. Species in the Blattidae family range from black and brown to red in color, but a few are even iridescent green. Some species have distinctive bands or spots, while others such as *Methana marginalis* have pale borders. Almost all species in the Blattidae family are flightless except for *Methana* species

### **Selected Blattidae species**

- Oriental cockroach
- American cockroach
- Australian cockroach
- Brown cockroach
- Smokybrown cockroach
- Florida woods cockroach
- Common shining cockroach
- Turkistan Cockroach (*Blatta lateralis*) Recent Addition

## **Cryptocercus**

Cryptocercus is a genus of Dictyoptera (cockroaches and allies) in the family Polyphagidae, of which this genus is the only member. Species are known as wood roaches or brown-hooded cockroaches. They are subsocial xylophagous insects, found in North America and Asia. There are 9 known species. Cryptocercus is especially notable for sharing numerous characteristics with termites, and phylogenetic studies have shown that this genus is more closely related to termites than it is to other cockroaches. Cryptocercus sp., apart from having a common ancestor with termites, have been placed within the Polyphagidae based on molecular analysis, and they are even closer relatives of *Therea* sp. (Grandcolas, 1996)

## **Dictyoptera**

Dictyoptera includes three groups of polyneopterous insects - cockroaches (Blattaria), termites (Isoptera) and mantids (Mantodea). While all modern Dictyoptera have short ovipositors, the oldest fossils of Dictyoptera have long ovipositors, much like members of the Orthoptera. The use of the term Dictyoptera has changed over the years, and while largely out of use for much of the last century, it is becoming more widely used. It is usually considered a superorder, with Isoptera, Blattaria and Mantodea being its three orders. In some classifications, however, Dictyoptera is shifted to order status. Regardless, in all classifications the three constituent groups are the same, just treated at different rank.

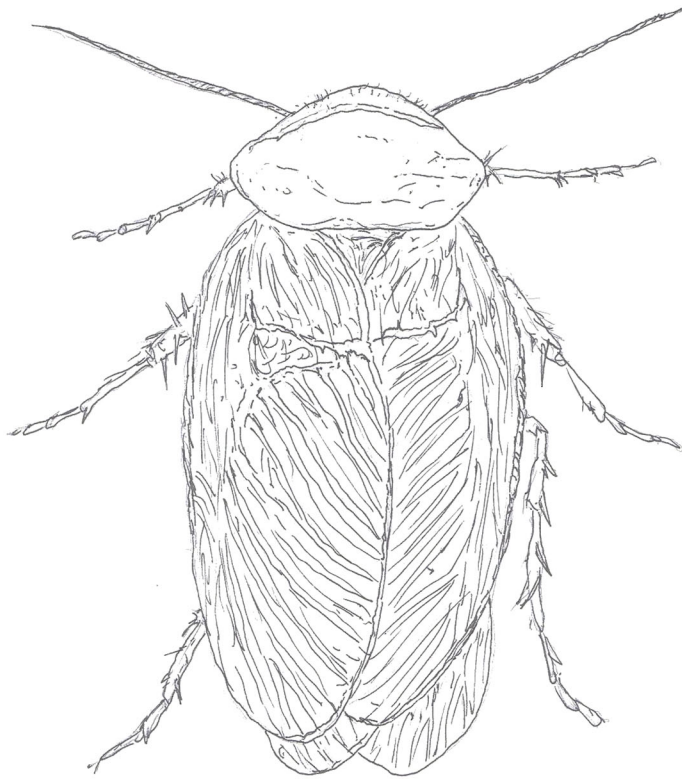
Termites and cockroaches are very closely related, with ecological and molecular data pointing to a relationship with the cockroach genus *Cryptocercus* (Lo et al., 2000.).

- ✓ Biting mouthparts.
- ✓ Cerci (two small appendages sticking out of the rear of the insect) are visible, and the hairs on the cercus are very sensitive to air movement in cockroaches, which explains why it is almost impossible to catch them.
- ✓ Cockroaches: about 4000 species worldwide, 130 in Europe, 9 in British Isles, but only 3 are native. Mainly nocturnal and omnivorous.
- ✓ Large or medium sized insects.
- ✓ The antennae are long, and may be longer than the entire body length.
- ✓ They can be separated into two sub orders, Blattodea (cockroaches), and Mantodea (mantids).
- ✓ They have two pairs of wings, but the front pair is leathery and held flat over the body when at rest.

## **Methana (Cockroach)**

### Species

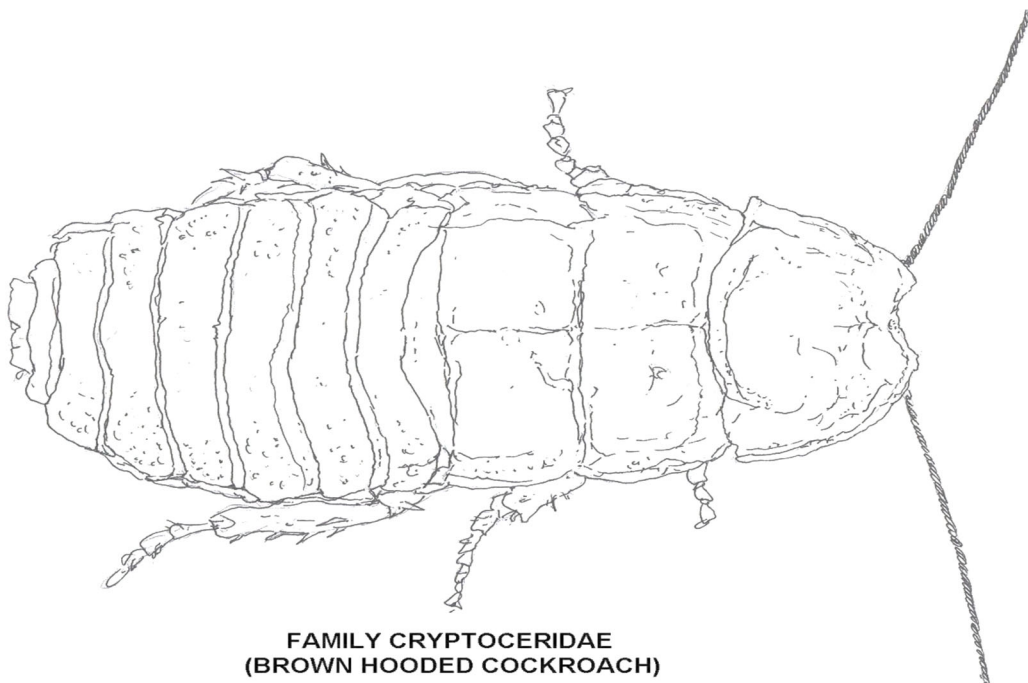
- *Methana athertonensis*
- *Methana caneae*
- *Methana convexa*
- *Methana curvigera*
- *Methana hacker*
- *Methana marginalis*
- *Methana mjoebergi*
- *Methana papua*
- *Methana parva*
- *Methana sjoestedti*
- *Methana soror*



**FAMILY PLOYTHAGIDAE**



**BLATTIDAE (PERIPLANETA AMERICANA)**



**FAMILY CRYPTOCERIDAE  
(BROWN HOODED COCKROACH)**



**AMERICAN COCKROACH AKA PALMETTO BUG**



**DESERT COCKROACH**

## **Polyphagidae (Sand Cockroaches)**

Polyphagidae is a family of the order Blattaria (cockroaches). Many are known as sand cockroaches. The family is divided into five subfamilies, comprising some 40 genera. One prominent species is the desert cockroach, *Arenivaga investigata*.

### **Sewer Roaches**

The American, Turkestan, Oriental cockroaches and American cockroach (Palmetto Bugs) are typically seen in damp areas, like sewers but can be seen anywhere that there is access to water. This type of roach is often seen around the perimeter of houses, sewers, basements, crawl spaces, porches, and even in your kitchen cabinets! Because these two roaches is an omnivore, it can survive just about anywhere and will feed on just about anything.

The comfortable temperature for a cockroach is about 84 degrees Fahrenheit. When temperatures are cooler, these roaches will move indoors through sewer connections, under doors, through crawl spaces, around utility pipes, air ducts, and cracks in the foundations of homes. When the temperatures rise, cockroaches can be seen more often outside on porches, and even on walkways. Many people think that because the city/sewer provider treats sewers for cockroaches, that the sewers are the only source of cockroach infestation.

The cockroach issue generally starts in dark places, like storage sheds and heavily shaded gardens, and then the cockroaches migrate to the home and hide in the drains of sinks. It is up to individuals to treat their own homes, meter boxes, storage sheds, mail boxes, dog houses and other areas cockroaches like to hide.

### **Here are some ways for customers to keep homes free of cockroaches:**

- Don't leave food uncovered, including pet food.
- Pick up clutter. Piled up newspapers and boxes give cockroaches a good place to hide.
- Pour a little bleach down drains in your kitchen, bathroom, and shower. Cockroaches don't like the smell.
- Keep drains covered when not in use. Cockroaches love to hide there.
- Keep windows and doors closed or tightly screened to keep out all insects, including cockroaches.
- Check boxes for cockroaches before bringing them into your home.
- Treat cracks and crevices in the walls and floor, and dark areas under kitchen appliances with roach control spray or dust on a regular basis.



American Cockroach (Palmetto bug), impossible to destroy completely.



## Commonly Found Cockroaches of the World

### Common Pest Cockroaches

Common pest cockroaches include the American, German, Oriental, Madeira, and brown-banded. The Asian cockroach began to cause concern in the United States when it appeared in large numbers in Florida in the late 1980s. All but the American cockroach are introduced species to North America. Again, we will cover these in detail in another section.

### Roaches from Around the World

In the UK the Oriental Cockroach *Blatta orientalis* is referred to as the "black beetle" due to its dark coloration. It is also called the "**mill beetle**" and the "**black clock**", probably due to its appearance at dusk in mills. In certain regions of Europe, the cockroach has been given local names which infer that the insect originates from a neighboring country, implying the neighbors are not as hygienic as themselves.

Examples for this are; "**Russe**" used in what was East Germany meaning "**Russian Cockroach**", in West Germany "**Franose**" is used, meaning "**French Cockroach**".

Many other colloquial names have arisen, in the USA around Philadelphia the Oriental Cockroach is called the "**Shad Roach**" due to its presence in high numbers at the time when Shad fish spawn in the river Delaware. "**Water bug**", "**Yankee settler**", "**Shiner**" "**Croton bug**" "**Steam-bug**" and "**Stream-fly**" are all local names for the German Cockroach in various regions of the world.

### Scientific Classification

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

The American cockroach is *Periplaneta americana*, and the Oriental cockroach is *Blatta orientalis*, both in the family Blattellidae.

The German cockroach, *Blattella germanica*, the Asian cockroach, *Blattella asahinai*, and the brownbanded cockroach, *Supella longipalpa*, are in the family Blattellidae.

The Madeira cockroach is *Leucophaea maderae*, the Brazilian cockroach is *Blaberus giganteus*, and the Madagascar hissing cockroach is *Gromphadorina portentosa*, all in the family Blaberidae. The remaining families are the Cryptocercidae and the Polyphagidae.

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

The Smokey Brown cockroach and the American cockroach look are similar in size and shape but the easiest way to distinguish between them is by color.

The Smokey Brown cockroach is usually dark brown to solid black in color and has no patterns on its body as an adult.

The American cockroach is a reddish-brown color and has some creamy coloration on its body right behind the head as an adult.

Adults are really the best way to tell which species you are dealing with. They can be identified because they have wings, and the immature stages do not. The immature stages are called nymphs and unfortunately the nymphs of both species look very similar. They are both a reddish-brown color until they reach adulthood.

They also have similar looking egg cases. They are both reddish-brown to black in color, and have similar looking ridges on the side.

Adult females of these species leave their egg cases in various locations to hatch. If you find an egg case that looks like a brown pellet with a zipper, you know you're dealing with large cockroaches. If the case does not have a zipper-look and has ridges that circle the case, this is a smaller cockroach and probably German cockroaches.

There are many smaller cockroaches that can be problematic in the southern region and they include: the German cockroach, the Asian cockroach, the Brown-Banded cockroach, and the Turkestan cockroach.
















The biggest pest problems (in terms of small cockroaches) come from the German cockroach.

Interestingly enough, the German and the Asian cockroach look very similar, indeed nearly identical. They are the same size and are light brown with two dark stripes right behind their heads. The easiest way to tell them apart is that German cockroaches don't fly. When frightened, Asian cockroaches will take flight while Germans never will. For control purposes the methods are nearly the same for these two species.

**Table 1. Life history of common cockroaches.**

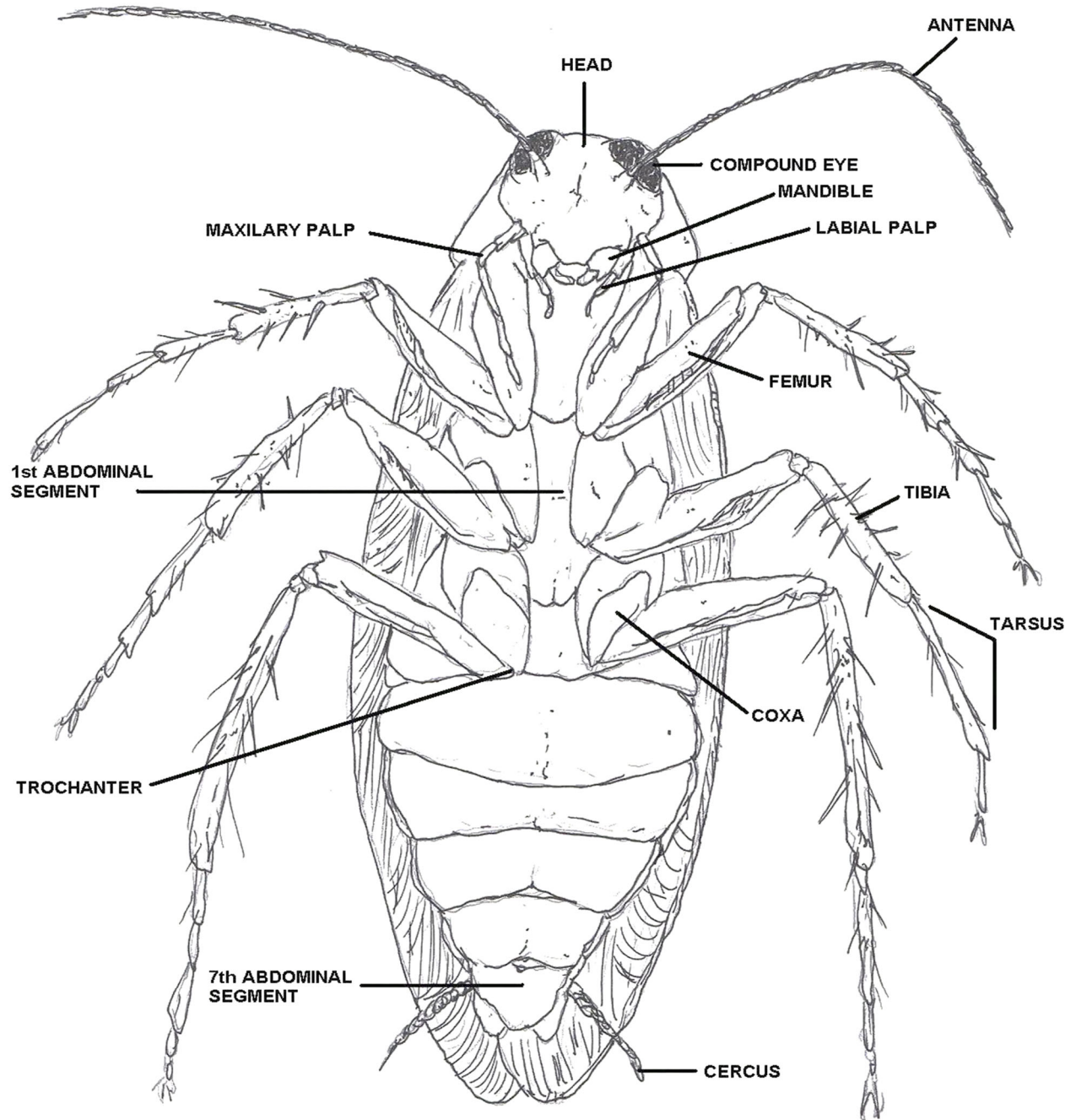
	GERMAN	AMERICAN	BROWN-BANDED	ORIENTAL	SMOKYBROWN
Average number of eggs per capsule	37	15	16	14	24
Average number of capsules per female	7	58	10	14	17
Number of molts	5-7	10 -13	7- 9	7-10	9
Nymphal stage (days)	103	468	161	542	344
Life cycle (days)	40 -251	320 -1071	143-379	215-991	311-513
Average longevity of adults (days)	140	441	115	96	247
Approximate number of offspring per year from one female under favorable conditions	35,000	812	677	196	306



	AMERICAN COCKROACH	ORIENTAL COCKROACH	SMOKEY BROWN COCKROACH	GERMAN COCKROACH	BROWN-BANDED COCKROACH
ADULT					
NYMPH					
EGG					



## COCKROACH IDENTIFICATION



**PERIPLANETA AMERICANA, VENTRAL SURFACE  
(FEMALE)**

## American Cockroaches (*Periplaneta americana*)



### AMERICAN COCKROACH

American Cockroaches are also known as a "water bug" or "palmetto bug". American cockroaches have three developmental stages: egg, nymph, and adult. The eggs are laid in capsules that are dark brown, symmetrically shaped, and about 5/16 inch long. The female drops her egg capsule within a day after it is formed. She often drops it in a suitable location near a food source or in a protected area. Each capsule averages 14 to 16 eggs. Usually one capsule is produced each week and is often glued to a hidden surface with secretions from the female's mouth. Each female produces from 15 to 90 egg capsules.

The American cockroach is the largest of the common species, growing to a length of 1 1/2 to 2 inches. It is reddish-brown with a light yellow band around the edge of the head shield. Adults of both sexes have well-developed wings, but seldom fly. They are, however, capable of gliding flights. Nymphal cockroaches are smaller than adults, grayish-brown in color and less fully winged.

The adult female usually drops her egg capsule within a day after it is formed. She often places the capsule near a food or water source or in a location where it can be covered with miscellaneous debris. Occasionally, she glues the capsule to some surface with secretions from her mouth. The capsule may be deposited outdoors in moist wood, in cracks in bark or in whorls of plants.

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

Both nymphs and adults are shiny, reddish brown with a pale brown or yellow band around the edge of the head and back. The wings of both the male and female extend slightly beyond the body.

The female produces 15 to 90 egg capsules, each containing 14 to 16 eggs.

Egg capsules are deposited near a food source where the majority of eggs hatch within 60 days.

The reproductive cycle is completed in 12 to 18 months. The adult can survive 2 to 3 months without food and for a month without water.

American cockroaches are not typically found in homes; however, in commercial and industrial establishments they can be found in damp, warm basements, in furnace or boiler rooms, and storage rooms. Because of their preference for sewers and heat tunnels, they are notable as a problem in urban commercial districts.

### **Diet**

American cockroaches feed upon a great variety of materials such as cheese, beer, leather, bakery products, starch in book bindings, manuscripts, glue, hair, flakes of dried skin, dead animals, plant materials, soiled clothing, and glossy paper with starch sizing.

The most important aspect of cockroach damage derives from the insects' habit of feeding and harboring in damp and unsanitary places such as sewers, garbage disposals, kitchens, bathrooms, and indoor storage indoors. Filth from these sources is spread by cockroaches to food supplies, food preparation surfaces, dishes, utensils, and other surfaces. Cockroaches contaminate far more food than they are able to eat.

### **Odorous Secretions**

From various points in their bodies American cockroaches, and cockroaches in general, produce odorous secretions that can affect the flavor of various foods. When populations are high, these secretions may result in a characteristic odor in the general region of the infestation. Disease-producing organisms such as bacteria, protozoa, and viruses have been found in cockroach bodies. Different forms of gastroenteritis (food poisoning, dysentery, diarrhea, etc.) appear to be the principal diseases transmitted by these cockroaches. These disease-causing organisms are carried on the legs and bodies of cockroaches, and are deposited on food and utensils as cockroaches forage. Cockroach excrement and cast skins also contain a number of allergens, to which many people exhibit allergic responses such as skin rashes, watery eyes, congestion of nasal passages, asthma, and sneezing.

### **Control Methods**

The best method for controlling American cockroaches is to keep them from establishing an infestation in the first place. Therefore, prevention methods are the first line of defense when dealing with American cockroaches.

### **Prevention (Non-Chemical)**

1. Exclusion: Inspect bags, boxes, cartons, etc. for evidence of American cockroaches before they are brought into the building. Cockroach evidence includes a "roachy" odor, feces, body parts, or live cockroaches. If evidence is found, do not allow the container into the building until it is emptied and all its contents inspected.

If cockroaches are already inside the building, limit their movements from place to place by sealing around pipe chases and conduit with expandable foam. Caulk and steelwool can be used to seal cracks behind cabinetry and under sink fixtures.

Screen vents in attics and crawlspaces, install door sweeps, and weatherproof window frames. Also, trim trees and shrubs so that they do not touch the structure. In buildings that are unoccupied, flush toilets regularly to prevent American cockroaches from entering through plumbing traps.

2. Sanitation: Eliminate as many moisture sources as possible. Fix leaking pipes, store recyclables (cans and bottles) outside the structure, insulate pipes to prevent condensation, and do not leave water standing in the sink. Eliminate all cockroach food sources. Clean up spilled pet food every day. Use a vacuum attachment to remove fallen crumbs from behind the stove and between cabinets. Avoid leaving unwashed dishes on countertops, and store all food in tightly sealed containers. Rinse cans and bottles before putting them in the trash or recycling. Take the trash out every night and place it in dumpsters or receptacles with tight fitting lids. Remove clutter. American cockroaches can use storage boxes, bags, paper goods, old clothes, and magazines as places to hide. Eliminating cockroach hiding places will make the environment much less hospitable to cockroach populations.

3. Monitoring: Sticky traps can be used to detect and monitor American cockroach infestations. Sticky traps can be placed in many locations throughout a structure. The traps should be left in place at least 24 hours so they are present at night when the cockroaches are most active. Cockroaches caught in monitoring traps can let you know that there is an infestation developing. The location of the trap full that catches cockroaches will give you clues as to where the cockroaches are harboring in the structure. Keep in mind that although sticky traps can detect cockroach populations, traps cannot control them. They will not catch enough cockroaches to eliminate an infestation, so other control measures will have to be employed. Do not ever use sticky traps outdoors because they will capture non-target animals like lizards, snakes, field mice, and beneficial insects.

### **Treatment (Chemical) *We will cover this more in detail in the next section.***

1. Baits: Cockroach baits consist of a toxicant (active ingredient) formulated in a food source. American cockroach baits are usually packaged as dusts, gels, pastes, or granules. Dust baits are applied into cracks, crevices, and wall voids with a bulb duster or as an aerosol formulation. Pastes and gels are usually purchased in a syringe, which can be used alone or inserted into a bait gun for more precise application. Most granular baits are applied outdoors in landscaping around the perimeter of the structure. However, some may be applied in wall voids using a bulb duster.

The most common and effective active ingredients formulated in American cockroach baits for consumer use include: hydramethylnon (Combat). and fipronil (Combat). Professional pest control products include dinotefuran (Advance), imidacloprid (Pre-empt), fipronil (MaxForce), hydramethylnon (MaxForce), indoxacarb (Advion) and acetamiprid (Transport). The advantages of using baits for American cockroach control is that baits generally have very low mammalian toxicity, and they can be placed in precise locations where they are available to cockroaches but inaccessible to people and pets.

2. Insect Growth Regulators (IGRs): IGRs for cockroach control are generally not available for homeowner purchase but are professional-use-only products. These compounds do not kill cockroaches. Instead, they disrupt the normal development of immature cockroaches making them functionally sterile as adults. The cockroach population then dies of attrition (which for American cockroaches can take over a year). Because of the slow-acting nature of IGRs, they are frequently used in combination with baits for faster control. While IGRs are certainly capable of controlling American cockroach populations, they are not commonly used for peridomestic cockroach control because the cockroaches are not breeding indoors.

However, to treat incipient populations in steam tunnels or boiler rooms, IGRs are available in spray formulations or point-source dispensers (the IGR is released on filter paper contained in a permeable plastic station and then transmigrates throughout the infested area). The most common IGRs (active ingredients) used in cockroach control products are hydroprene (Gentrol Point Source) and pyriproxyfen (Nylar).

3. Aerosol Sprays: There are a large number of consumer aerosol products available for killing cockroaches. These products will not control an infestation, but will kill individual cockroaches sprayed with the product.

Keep in mind that one two-second application of spray is enough to kill a cockroach. It may not die immediately, but it will die within a few minutes. It is not necessary to empty half a can of spray on a single cockroach until it completely stops moving.

Applying this much insecticide to a single cockroach is a pesticide contamination risk for people and pets living in the structure. Always be sure to read the product label and only apply the recommended amount of insecticide.

### **Treatment (Non-Chemical)**

1. Inorganic Dusts: These dusts are normally applied for indoor cockroach control with a squeeze-bulb duster, which puffs the dust into cracks and crevices. Examples of these dusts are silica aerogel and boric acid. Silica aerogel is a finely ground silica (similar to glass) that adheres to the cuticle of the cockroach and absorbs the protective wax covering. This dehydrates the cockroach and eventually kills it. Boric acid dust is a stomach toxicant that also adheres to the cockroach when it walks across the dust. The cockroach then grooms itself using its mouthparts and ingests the dust in the process.

2. Captured American cockroaches can be killed by placing them in hot soapy water. The soap disrupts cockroaches' ability to close their breathing tubes and they drown in the hot water. This type of death is not instant, so do not be surprised if the cockroaches swim around for a while before dying. Be sure that the cockroaches cannot climb up and out of the water container. Stepping on the cockroaches is a quicker and equally effective method of control.

American cockroaches can be controlled outdoors with liquid insecticides or baits if you spend the time to find and target the infested sites. Persistent residual pesticides may be applied around the foundation and points of entry such as windows, doors, and utility penetrations. Once the chemical has been applied, it is best to seal cracks, crevices, and holes on the building to enhance long-term control.

### **Bait Formulations**

Bait formulations of a variety of slow-acting chemicals are widely used for cockroach control indoors and outdoors. Bait formulations include liquids, pastes, gels, and granules; often the bait is housed in a station. Baits can provide effective control, but the cockroaches must preferentially feed on the baits rather than existing food sources. Hence, it is particularly important to employ sanitation measures (see above) when using cockroach baits.

## Asian Cockroach (*Blattella asahinai*)



**ASIAN COCKROACH (ADULT)**

The Asian cockroach was identified as a newly introduced species to the United States in 1986 when a professional pest control operator collected these insects in Lakeland, Florida. He referred to them as German cockroaches, *Blattella germanica* (L.), but noted that their behavior was unlike any other German cockroaches that he had previously encountered. Upon further investigation the cockroaches were found to be *B. asahinai*, Asian cockroaches.

### **Distribution and Habits**

The Asian cockroach was first described in 1981 from insects collected on Okinawa Island, Japan. It is most likely that *B. asahinai* was introduced into the United States through imports from Japan. Since the first identification of *B. asahinai* in Lakeland (Polk County), it has been reported from Marion County in central Florida to Broward County in southwest Florida.

The primary habitat of the Asian cockroach is outdoors in shaded mulched or composted areas, such as landscaping and gardens, where fresh plant litter accumulates. Populations of 30,000 to 250,000 insects per acre have been reported. Members of this species are strong fliers, unlike their close relative, the German cockroach. They may invade structures but indoor infestations are rare occurrences.

They become active at sundown and are attracted to light-colored surfaces and brightly lit areas. Adults will take flight during the day if disturbed. The presence of this pest is obvious since their peak activity period coincides with our leisure time.



### **ASIAN COCKROACH (LOOKS LIKE A GERMAN COCKROACH)**

#### **Description**

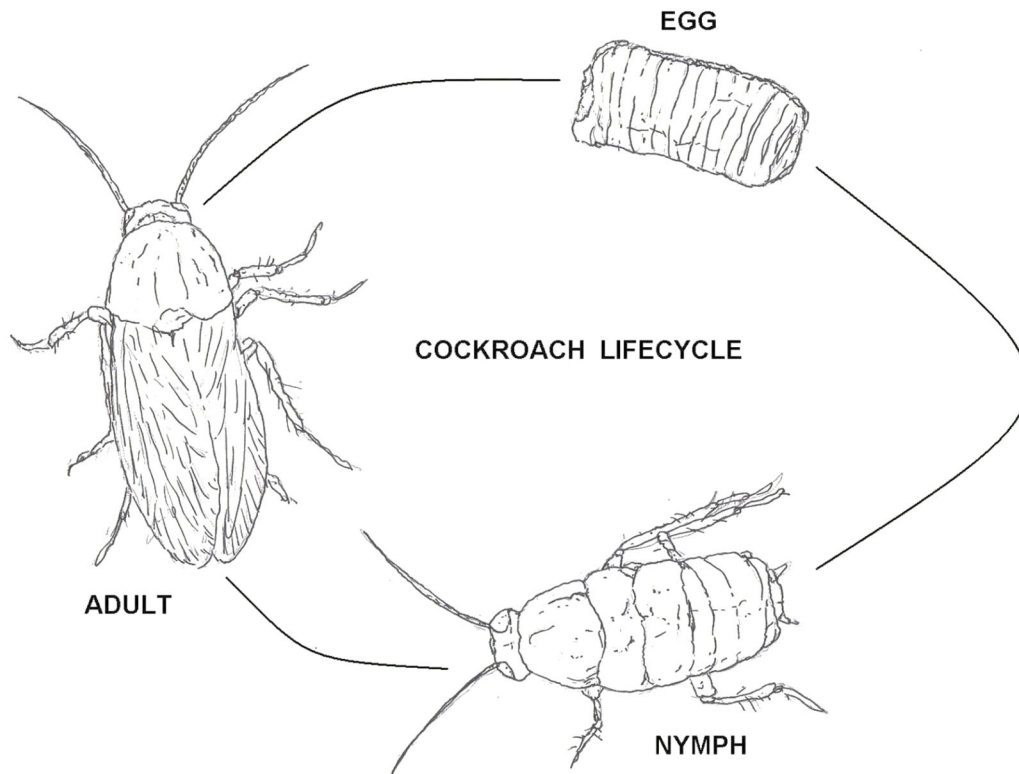
Asian cockroaches are almost identical to German cockroaches. Chemical analysis by gas chromatography will confirm the species. However, there are also slight morphological differences between *B. asahinai* and *B. germanica*. Asian cockroach adults have longer and narrower wings than those of German cockroaches.

There are also differences between the species in the shape of the male tergal glands. Asian cockroach females produce smaller egg capsules and nymphs are smaller than that of German cockroaches. Asian cockroach first instars have 23 antennal segments while German cockroach first instars have 24 to 25. Finally, margins of the abdomen and spots along the abdominal midsection of *B. asahinai* late instars appear white, whereas those areas are lightly pigmented in *B. germanica*.

#### **Asian Cockroach Life Cycle**

Female Asian cockroaches have a lifetime reproductive potential for producing approximately four egg capsules, each averaging 37 nymphs. Immatures take approximately 67 days to reach adulthood. Females can then live for 104 days and males can live for 49 days. Females can produce their first egg capsule 13 days after adult eclosion, and can drop another 20 days later. Adults are abundant February through May and again August through September. Nymphs predominate May through August.

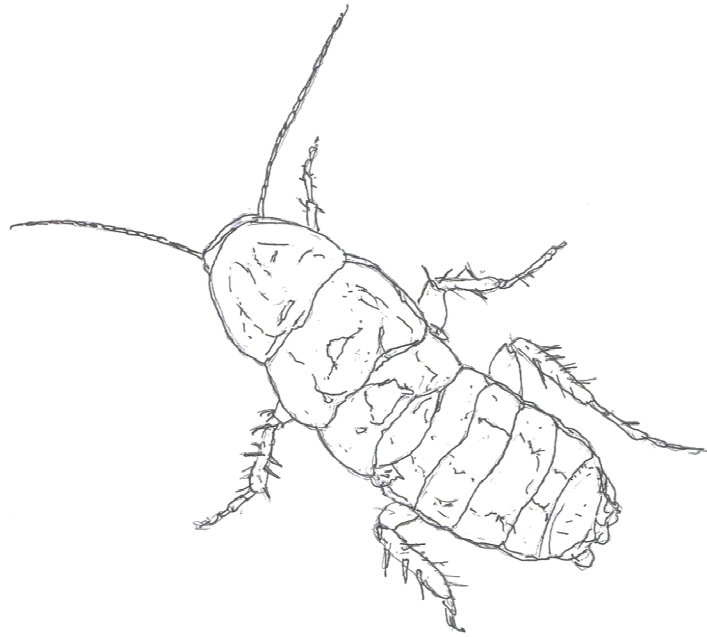




### **Asian Cockroach Management**

Control of Asian cockroaches is difficult due to their mobility and abundance of population sites. Traditional treatments using residual sprays inside and around the perimeter of a structure are ineffective due to numerous infestations in mulched and wooded areas.

Plus, adults enter homes through windows and doorways, avoiding areas typically treated for control of German cockroaches. Sodium vapor lamps for security lighting and yellow incandescent bulbs for porch lighting are both less attractive to adults and would thereby reduce attraction of adult insects to lighting near buildings. Although Asian cockroaches are susceptible to all pesticides, toxic pelletized baits scattered outdoors have provided the most reliable control.



**BROWN HOODED COCKROACH**



**BROWN – BANDED COCKROACH**

## **Brownbanded Cockroach (*Supella longipalpa*)**

Both nymphs and adults of this species are light brown and can be distinguished easily by the presence of two angled or transverse bands across the base of the wings and abdomen. Adult males are 1/2 to 5/8 inch long; the female is slightly shorter. Though both have wings, only the male can fly.



### **BROWN – BANDED COCKROACH**

The female carries each egg capsule for only a day or two before attaching it to a protected surface. The egg capsules are usually deposited in clusters or rows, and most of the eggs hatch within 50 days. Approximately 5 to 18 egg capsules are produced per female, each containing 19 eggs. About 3 to 9 months are required to complete the reproductive cycle.

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

The wings of adult males cover their abdomens, while the females' wings are shorter. The yellow bands across the back are more pronounced on nymphs than on adults. These cockroaches are quite active, and the adults, especially the males, fly rapidly when disturbed. Both adults and nymphs may jump to escape danger.

### **Brownbanded Cockroach Adult Female**

The adult female carries her egg capsule for only a day or two before gluing it to a protected surface underneath or inside furniture, in a closet or on the ceiling in a darkened room. They can also be found in televisions and other appliances.

Brownbanded cockroaches are more apt to be found in homes, apartments, hotels, motels, nursing homes and hospitals than in restaurants, grocery stores and other commercial establishments. They prefer starchy foods and appear to have lower water requirements than other cockroaches.

They can occupy drier locations within a building. Nymphs and adults frequently are found on ceilings in dark or dimly lit rooms, behind picture frames, in light switches, in upper walls of cabinets and closets, or on undersides of furniture and inside upholstered furniture. Because brownbanded cockroaches are found in so many locations they may be more difficult to control.

### **Starchy Food**

Brownbanded cockroaches prefer starchy food (e.g., glue on stamps and envelopes), are often found in offices and other places where paper is stored, and are more common in apartments or homes that are not air conditioned. They also infest animal-rearing facilities, kitchens, and hospitals. Adult males sometimes fly when disturbed, but females do not fly. Females glue light brown egg cases, which are about  $\frac{1}{4}$  inch long, to ceilings, beneath furniture, or in closets or other dark places where eggs incubate for several weeks before hatching. Each female and her offspring are capable of producing over 600 cockroaches in one year. The brownbanded cockroach feeds on a wide variety of materials. Like members of other cockroach species, it may consume materials like glue or paste (especially from animal-based materials), starch, and certain color dyes. As a result, items like stamps, envelopes, bindings of older books, draperies, and occasionally wallpapers may show signs of feeding.

### **Nonfood Materials**

This species has also been known to chew on nonfood materials, such as nylon stockings, presumably for the residues of body oils and skin flakes. Damage by brownbanded cockroaches results from their feeding and harboring in pantries and storage areas indoors. Also, bacteria and protozoa that cause diseases (such as different forms of gastroenteritis and diarrhea) can be carried on the legs and bodies of cockroaches and deposited on food, utensils, etc.

### **Odorous Secretions**

Cockroaches in general produce odorous secretions from various points in their bodies. Such secretions can affect the flavors of various foods. When cockroach populations are high, these secretions may result in a characteristic odor in the general region of the infestation. Disease-producing organisms such as bacteria, protozoa, and viruses have been found in their bodies. Different forms of gastroenteritis (food poisoning, dysentery, diarrhea, etc.) appear to be the principal diseases transmitted by cockroaches. The insects carry these disease-causing organisms on their legs and bodies and deposit the organisms on food and utensils as they forage. Cockroach excrement and cast skins also contain a number of allergens, to which many people exhibit allergic responses such as skin rashes, watery eyes, congestion of nasal passages, asthma, and sneezing.

## **Brownbanded Cockroach Management Strategies**

### ***Survey We will cover this more in detail in the next section.***

To control brownbanded cockroaches, it is important to do a thorough inspection, or survey. Cockroach surveys involve placing sticky traps at strategic locations within the building. Whenever possible, place survey traps either against a wall or in a corner of the floor, a shelf, or a drawer. Most commercially available traps come complete with bait to encourage cockroaches to enter. One week of trapping with a sufficient number of trap sites (ten or more) usually provides enough information for effective control. Treatments should be directed to those areas where cockroaches have been collected in the traps.

### **Sanitation, Structural Modifications, and Repairs**

Brown banded cockroaches are carriers of pathogens and can contaminate food with certain bacterial diseases that result in food poisoning, dysentery or diarrhea. Some homeowners are allergic to Brown banded cockroaches; some health experts have claimed that the inhalation of feces and body fragments have caused an increase in asthma cases, especially in inner-city children.

In controlling brown banded roach infestations, it is helpful to seal cracks and holes behind toilets and around plumbing pipes under sinks. Also, do not store cardboard boxes and paper bags under sinks or in the kitchen or bathroom since they tend to congregate in them. Inspect stored food containers, appliances and used furniture for egg cases that may be brought into the home. It is difficult to keep cockroaches from entering the home via boxes, grocery bags, suitcases, etc., but you can prevent them from developing into a serious problem. One of the key factors is sanitation. Clean up spilled foods on the floor. Do not leave dirty dishes overnight. Store items such as cereal, crackers, and cookies in airtight containers. Empty garbage each evening into a sturdy container with a tight-fitting lid.

Brown-banded cockroaches can conceal themselves in many places that are inaccessible to larger species. Making structural modifications such as caulking (in cracks, crevices; around ducts, molding, etc.) is necessary in bedrooms, bathrooms, dining rooms, and other areas of the house.

### **Chemical Control**

Baiting is an effective method to control or eliminate brownbanded cockroaches. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin can provide a high level of control when applied to those areas where cockroaches harbor. Some formulations of baits are available to the public in plastic feeding stations.

Professional pest control personnel also have cockroach baits in flowable granular and gel formulations. Care should be taken to closely follow the label instructions for use.

Insecticidal dusts like boric acid, silica aerogel, and diatomaceous earth can provide additional control. Apply dusts lightly, as heavy deposits may repel cockroaches. These products can be applied in the cracks and crevices of bureaus, clothes closet shelves, ceiling light fixtures, valances above windows, hollow legs of chairs and tables, and wall or floor cracks and crevices throughout the house.

Do not place dusts where they could come in contact with children or pets. Do not allow children access to areas treated with boric acid. Boric acid is of low toxicity to adults, but it can present a hazard to children. Take precautions to assure that dusts do not contaminate food. The use of residual insecticidal sprays or aerosol foggers within a structure is of little value in controlling brownbanded cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy.

### **Control Brownbanded Cockroaches**

1. For indoor infestations, spray Suspend SC all along the baseboards, window and door frames, and underneath appliances using a handheld sprayer. Repeat this treatment every two to three months.
2. Dust underneath baseboards and inside wall voids with Delta Dust.
3. Outdoors, use a residual spray such as Talstar One or Cynoff WP outside around all points of possible entry including windows and door frames, dryer vents, and pipe openings. Use the same residual indoors along baseboards and framed entry points.
4. Recommended baits for Brownbanded roach control include Advion Roach Bait Gel and Maxforce Roach Bait Stations. Each roach feeding on Maxforce Roach Gel can kill up to 40 other roaches via droppings and dead bodies.

Cockroaches need water as well as food, so check for condensation or leaks providing a water source. Don't forget to consider less obvious sources of water such as planters, pet water dishes and fish tanks.

## ***Blaptica dubia*, the Dubia roach**

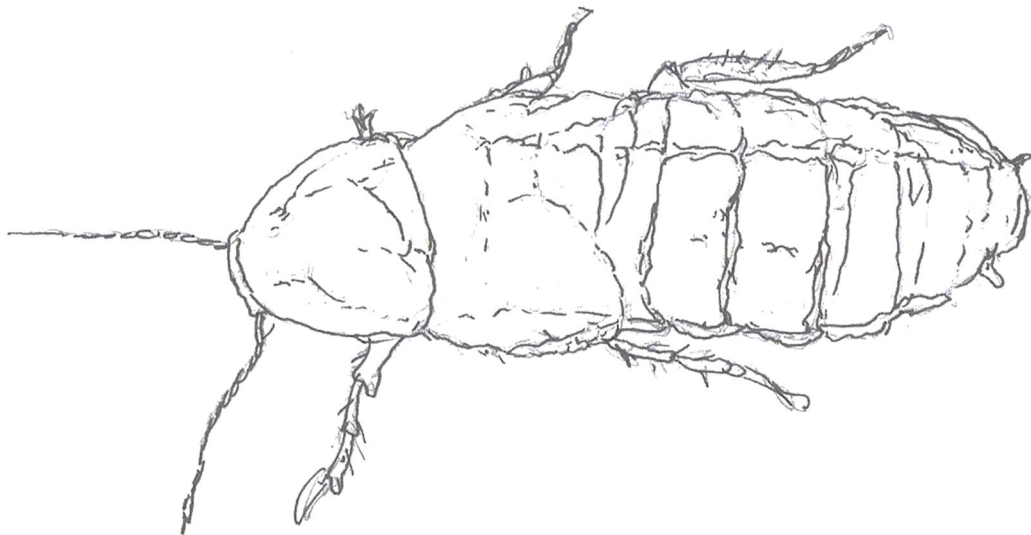


### **BLAPTICA DUBIA (COMMON PET)**

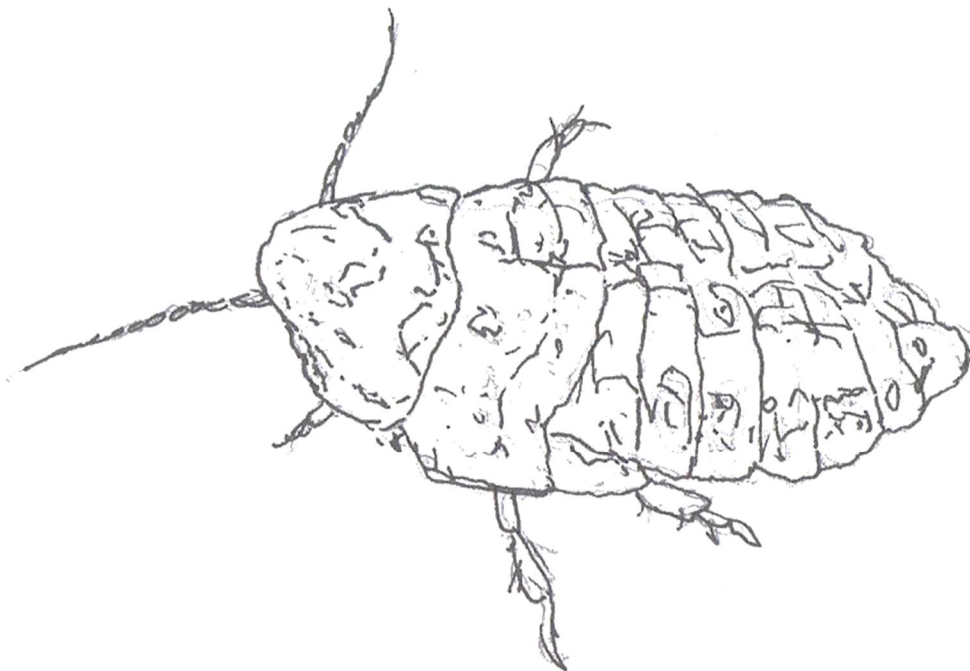
***Blaptica dubia*, the Dubia roach, also known as the orange-spotted roach, Guyana spotted roach, or Argentinian wood roach, is a medium-sized species of cockroach which grows to around 40–45 mm (1.6–1.8 in). They are sexually dimorphic; adult males have full wings covering their body, while females have only tiny wing stubs, their tegmina (forewings) being around a fourth of their body length.**

Adults are dark brown to black with somewhat lighter orange spot/stripe patterning sometimes visible only in bright light. Coloration does differ slightly with environment and diet from one colony to another.

*Blaptica dubia* are partially ovoviviparous, giving birth to live young after eggs hatch inside the female, and can give birth to 20 to 40 nymphs per month under favorable conditions. The Dubia cockroach is found in Central and South America, beginning in Costa Rica. It is common from French Guiana and Brazil to Argentina.



**BLAPTICA-DUBIA COCKROACH – FEMALE**



**BLAPTICA-DUBIA COCKROACH - JUVENILE**



## Brown-Hooded Cockroach (*Cryptocercus*)



### **BROWN-BANDED COCKROACH**

*Cryptocercus* is a genus of Dictyoptera (cockroaches and allies) in the family Polyphagidae, of which this genus is the only member. Species are known as wood roaches or brown-hooded cockroaches. They are subsocial xylophagous insects, found in North America and Asia. There are 9 known species.

*Cryptocercus* is especially notable for sharing numerous characteristics with termites, and phylogenetic studies have shown that this genus is more closely related to termites than it is to other cockroaches. *Cryptocercus* sp., apart from having a common ancestor with termites, have been placed within the Polyphagidae based on molecular analysis, and they are even closer relatives of *Therea* sp. (Grandcolas, 1996 and later). *Cryptocercus* cockroaches occur in Oregon and Northern California, as well as pockets of the SE USA (excluding Florida).

They are rarely encountered as colonies of them live in and feed on rotting logs. They are seldom offered to the pet hobby. Cockroaches nutritionally benefit from a substrate of mixed organic matter. The pair feed their offspring for several months after hatching. They inhabit moist, forested areas and are related to termites.

### **Exterior Treatments**

Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels.

Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair. Changing white incandescent bulbs to yellow bulbs around entrance doors may help.

### **Chemical Control**

Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior.

Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application. The use of residual sprays or aerosol foggers within a structure is of little value in controlling cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy.

Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.

## Cuban Cockroach (*Panchlora nivea*)



### **CUBAN COCKROACH**

**Looks similar to a German, but has a beautiful green color.**

The Green banana cockroach (*Panchlora nivea*) is a small species of cockroach that is found in Cuba and the Caribbean, and along the gulf coast from Florida to Texas and has been observed as far north as Charleston, South Carolina. It is also called the Cuban cockroach. It prefers subtropical or tropical climates and is currently not found beyond these areas. It is usually an outdoor species and is rarely found indoors and thus is not considered a pest. The adults can often be found in shrubbery, trees, and plants. The young can be found under logs and other debris. It is often attracted to bright lights and it is mainly a nocturnal species. It is often a popular pet roach due to its relatively pleasant green color and the fact it is not an invasive indoor species.

The females can grow up to 24 mm and the smaller males are 12 to 15 mm long. It is winged and a strong flier. They are light green in color with a yellow line running up the sides. The adults love to climb. The nymphs are brown or black in color and are burrowers.

#### **Cuban (Green Banana) Cockroach Habitat**

The Cuban cockroach, also called the green banana cockroach, is an outdoor tropical species. They can be found in woodpiles, shrubbery, trees, and plant leaves. Nymphs can be found in leaf litter and debris. Cuban roach encounters are likely to occur in homes in rural, wooded areas.

#### **Control**

Since Cuban cockroaches are attracted to light and are also good fliers, keeping outdoor lights off when not in use, as well as using lower-wattage light bulbs, may help to discourage their presence. Scattering wood, lumber and leaf or debris piles will also keep this, and many other, cockroach species from nesting.

### **Cuban (Green Banana) Cockroach Control**

Controlling this roach is normally straightforward and fairly simple. Desiccant dusts and a good baiting system are usually sufficient to gain good control. The sprays and dusts used with success against household cockroach species are of very limited benefit against roaches. Exclusion techniques that prevent roach entry should be considered.

Doors and windows should be tightfitting and cracks, gaps and other possible entry points should be sealed. If a breeding site can be moved or modified (e.g., relocating a wood pile farther from the house) it might help. Also, store firewood outdoors until you are ready to burn it.

The males are attracted to lights at night and limiting porch light use in late May through June when males are flying might be of some benefit. Outdoor insecticide barrier treatments around windows and doors and along the foundation. Direct application of insecticide to firewood does no good and is discouraged. Cockroaches inside need only be picked up discarded.

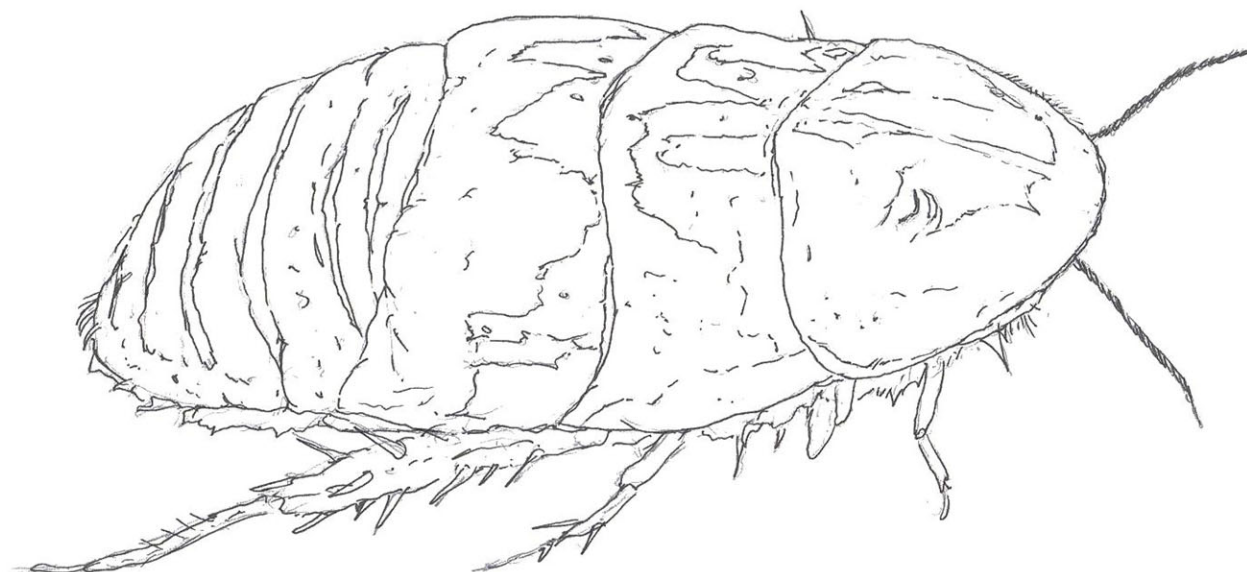
### **Cuban (Green Banana) Cockroach Chemical Control**

As breeding populations rarely become established indoors, house interiors should not be treated. Treat exteriors only when cockroaches enter homes from the surrounding environment.

Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair.

## Desert Cockroach (*Arenivaga genitalis*), (*Arenivaga investigata*)



### DESERT COCKROACH

Males are 18-20 mm ( $\frac{3}{4}$ " ) long and have a delicate brown-on-tan pattern on the pronotum. The wings are a mottled tan and longer than the abdomen. Females are 12-14 mm ( $\frac{1}{2}$ " ) long and have a broadly oval, somewhat hump-backed appearance. Females are wingless and may resemble dark brown sow bugs to the untrained eye. Recognizable by its cockroach shape, but not by its habits. Males are nocturnal and are strongly attracted to lights. They seldom enter homes unless doors are open and lights are left on. Females spend their lives burrowing in soft soil where they feed on organic debris. They are typically associated with pack-rat or other desert rodent burrows where the soil has been loosened and organic material is abundant.

The desert cockroach, *Arenivaga investigata*, can gain weight by absorption of water-vapor from unsaturated atmospheres above 82.5% relative humidity. Blocking the anus or the dorsal surface with wax does not prevent water vapor uptake, but interference with movements of the mouthparts or blocking the mouth with wax-prevents such uptake. Weight gains are associated with the protrusion from the mouth of two bladder-like extensions of the hypopharynx.

During absorption these structures are warmer than the surrounding mouthparts, their surface temperature increasing with relative humidity. This suggests that the surfaces of the bladder-like structures function at least as sites for condensation of water vapor, but the precise location of its transfer into the hemolymph has not yet been identified.

#### Desert Cockroach Control

Controlling this roach is normally straightforward and fairly simple. Desiccant dusts and a good baiting system are usually sufficient to gain good control. The sprays and dusts used with success against household cockroach species are of very limited benefit against roaches. Exclusion techniques that prevent roach entry should be considered.

Doors and windows should be tightfitting and cracks, gaps and other possible entry points should be sealed. If a breeding site can be moved or modified (e.g., relocating a wood pile farther from the house) it might help. Also, store firewood outdoors until you are ready to burn it. The males are attracted to lights at night and limiting porch light use in late May through June when males are flying might be of some benefit. Outdoor insecticide barrier treatments around windows and doors and along the foundation. Direct application of insecticide to firewood does no good and is discouraged. Cockroaches inside need only be picked up discarded.

### **Desert Cockroach Chemical Control**

As breeding populations rarely become established indoors, house interiors should not be treated. Treat exteriors only when cockroaches enter homes from the surrounding environment. Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage).

Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Common names (the names found on the list of active ingredients) of other effective pesticides include: propoxur (Baygon), cyfluthrin, permethrin, deltamethrin, and tetramethrin. A variety of formulations may be available, including sprays (liquid or wettable powders), aerosol sprays, baits or dust. No single chemical or formulation will control all cockroaches. Some German cockroach infestations are resistant to one or more insecticides. Apply insecticides only to cracks, crevices, or unexposed surfaces, and not beyond the point of runoff. Avoid spraying carpets, wallpapers, or other furnishings that might be stained.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures are what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8-inch mesh. Window screening must be kept in good repair. Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas.

### **Boric Acid**

Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application.

## Death's Head Cockroach (*Blaberus craniifer*)



### DEATH'S HEAD COCKROACH

The true death's head cockroach, *Blaberus craniifer*, is a cockroach which is very similar to the discoid cockroach and is a nice display animal for entomologists due to its striking appearance. Care for these animals is quite minimal and there is little odor associated with them. They do give off a mild odor if significantly frightened, but the effect is generally brief.

The name death's head comes from the markings on the top of the thorax. Adult *B. craniifer* have wings but do not fly, while juveniles do not have wings at all. This species also cannot climb smooth vertical surfaces, such as glass, which makes them easy to house in an open aquarium or similar.

*Blaberus craniifer* is the most misidentified and certainly one of the most difficult to find roaches. Most Roaches commonly sold as Death Head Roaches are either a *Blaberus craniifer* cross or another species, usually Discoid Roaches. Death Head Roaches are a live bearing species that grow to three inches or more. They are nervous roaches that are slow breeders. However, they are striking looking roaches. Adults have wings but do not fly, while juveniles do not have wings at all.



**DEATH'S HEAD COCKROACH – SEE DEATH'S FACE IN DETAIL**



**DISCOID COCKROACH – JUVENILE**



## **Discoid Cockroach (False Death's Head Cockroach)**

The discoid cockroach is also commonly called the false death's head cockroach. This species of roach lives in tropical South America. They can grow up to 7.6 cm (3.0 in) long and although they have wings as adults, they do not fly. They also cannot climb smooth surfaces such as glass. These two characteristics make them easy to raise in an aquarium and they do not even require a lid. Most high protein food sources are sufficient to maintain them, such as dry dog food.

This species ranges in size from 35-45mm. Although branded as false death heads these roaches have no noticeable similarities to *B. craniifer*. Discoids have been one of the more common feeder roaches in the US pet industry for the past few years. These roaches usually reach adulthood in 3-5 months and then will live another 10-14 months. Both males and females have wings, but this is a non-climbing or flying species. This is not a native species, but because these cockroaches are used for feeding pets, it is more and more common to treat homes that have allowed these pests to escape and thrive.

The name death's head comes from the markings on the top of the thorax. Adult "*B. craniifer*" have wings but do not fly, while juveniles do not have wings at all. This species also cannot climb smooth vertical surfaces, such as glass, which makes them easy to house in an open aquarium or similar.

### **Pet Feeders**

They are very easy to raise in captivity and therefore make good food for pets such as tarantulas, bearded dragon and other lizards. They breed somewhat faster than the true death's head cockroach. Most high protein food sources are sufficient to maintain these as feeders, such as dry dog food. Misting with water is required to maintain a high humidity level in captivity and to supply drinking water. A sponge in a shallow dish is also effective for drinking water. The markings on the back of the head give rise to the name death's head since it appears to be something like a vampire symbol to many people.

These animals breed readily in captivity. They reach breeding age in about 6 months if kept warm, with 85°F-90°F being recommended for more productive breeding. Females will carry their eggs inside a brooding pouch within their abdomen until they hatch. Discoid cockroaches also produce considerably less odor than crickets, another common feeder animal. They can survive on many substrates and to some extent they will clean their own cage, only requiring cleaning on a monthly basis or less.

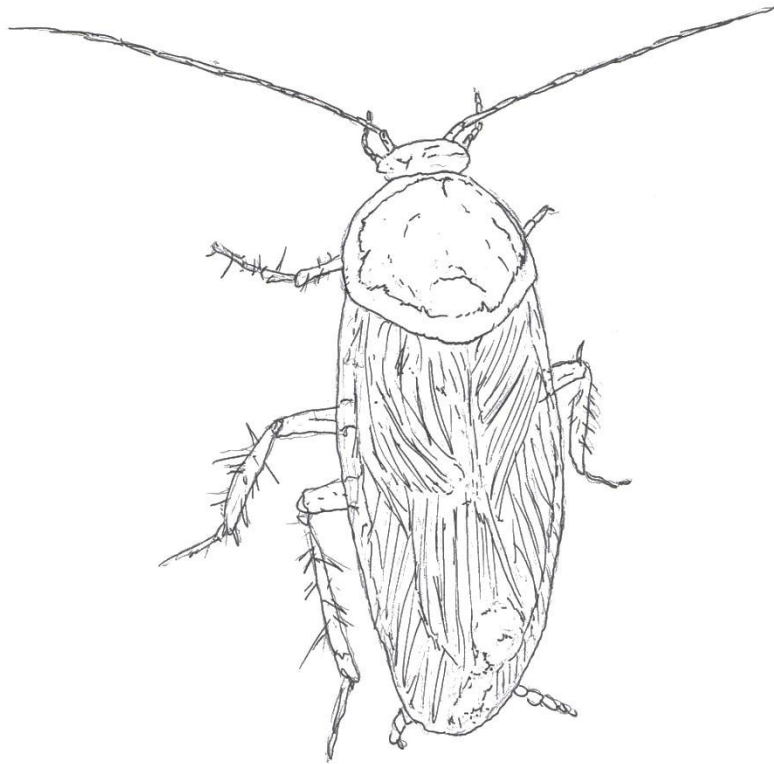
Coconut fiber makes a good substrate as the nymphs readily burrow in it, and it holds humidity well. They can eat and should be given a variety of fresh fruit and vegetable scraps. Keep their food in a dish (or two) dry food and wet/fresh separate. On the opposite side of the tank keep an auto water dish or just a shallow water dish and replace when empty or dirty. Keep the roaches on mulch or peat and give them egg crates to spread out on. Also even though they cannot climb glass they can climb silicone and will climb the corners of the aquarium. If they get out they will desiccate if not given a water source, thus reducing the risk of infestation.

### **Life Cycle**

Cockroaches have incomplete metamorphosis. Most species of cockroaches lay eggs in an ootheca (egg case) that is either deposited on or under suitable substrate, or carried attached to the genital region.

The egg stage lasts from a few weeks to a few months. The young are active from hatching and resemble the adults but are usually lighter in color and lack wings. The young cockroaches develop through a number of nymphal instars, which may range from 2 to 12 depending on the species and may take from a month or so up to 12 months to reach maturity. Some species may live for several years.

**Field Cockroach (Pale Bordered Field Cockroach)**  
*(Pseudomops septentrionalis)*



**FIELD COCKROACH**

The Field cockroach is very similar in appearance to the German cockroach. It can be distinguished from the German cockroach by the blackish/brown area on the face from mouth parts to between the eyes. This species is slightly smaller and more greenish-brown in coloration than is the German cockroach.

The field cockroach, unlike the German cockroach, is not repelled by light and can often be seen during the day. It is most common in irrigated regions of southern Arizona and adjacent areas in southern California. It is associated with and feeds largely on decomposing vegetation; it also occurs under stones, clumps of earth, and similar objects. During the drier part of the year, it temporarily may come into the house in search of moisture.

**Life Cycle**

A life cycle can be completed in about 3 months. Female field cockroaches carry their egg capsules until they are ready to hatch. The number of eggs in a capsule usually is between 30-40, with a maximum of 48. The average number of nymphs hatching is 30. The average incubation period is 28.4 days. Capsules removed from the female do not usually hatch. Females at room temperature may produce an average of 4-5 capsules. The time for nymphs to mature to adults averaged 103 (54-215) days.

They progress through 6-7 nymphal instars in 60 days for males and 65 days for the females. Females may live for more than 200 days. Simple metamorphosis (egg, nymph, adult). Female cockroaches glue or drop 1/4 inch long bean-like egg capsules (oothecae) containing about 15 eggs on or around infested areas. Nymphs hatch from the egg case that resemble small grayish-brown adult cockroaches without fully developed wings. Nymphs molt 10 to 13 times in over a year (470 to 600 days, depending on temperature) before becoming adults.

### **Habitat, Food Source(s), Damage**

This is generally an outdoor species, living in wood piles, decaying trees, palm trees and in sewer systems. Cockroaches have flattened bodies that allow them to enter homes through cracks around loose-fitting doors and windows, and where electric lines or pipes pass through walls. They are mainly active at night and hide in cracks and crevices during the day, preferring dark moist sites in attics and basements. Cockroaches eat almost anything including meats and grease, starchy foods, sweets, baked goods, leather, wallpaper paste, book bindings and sizing. Adults are capable of gliding flights.

### **Similar to Oriental Cockroach**

Another similarly-sized, black-brown, common indoor species is the oriental cockroach, *Blatta orientalis* Linnaeus, but it differs because the wings on adults are rudimentary on the female and only cover 75% of the abdomen of the male. Other cockroach species come in a variety of sizes and shapes. Most are dark brown with or without color patterns on the body. Occasionally, a whitish cockroach is observed incorrectly thought to be an "albino" form. These are, in fact, roaches that have just molted and have not yet had time to darken their "new" exoskeleton.

### **Similar to Cuban Cockroach**

There is, however, a pale green cockroach species, the Cuban cockroach, *Panchlora nivea* (Linnaeus) (Blattodea: Blaberidae), which is occasionally encountered. Other common outdoor species include wood roaches, *Parcoblatta* spp. (Blatellidae) and the pale-bordered field cockroach, *Pseudomops septentrionalis* Hebard (Blattaria: Blattellidae).

### **Pest Status**

Although not shown to be direct carriers of disease, they can contaminate food and kitchen utensils with excrement and salivary secretions and leave an unpleasant odor.

### **Odorous Secretions**

Cockroaches in general produce odorous secretions from various points in their bodies. Such secretions can affect the flavors of various foods. When cockroach populations are high, these secretions may result in a characteristic odor in the general region of the infestation. Disease-producing organisms such as bacteria, protozoa, and viruses have been found in their bodies. Different forms of gastroenteritis (food poisoning, dysentery, diarrhea, etc.) appear to be the principal diseases transmitted by cockroaches. The insects carry these disease-causing organisms on their legs and bodies and deposit the organisms on food and utensils as they forage. Cockroach excrement and cast skins also contain a number of allergens, to which many people exhibit allergic responses such as skin rashes, watery eyes, congestion of nasal passages, asthma, and sneezing.

### **Field Cockroach Control**

Controlling this roach is normally straightforward and fairly simple. Desiccant dusts and a good baiting system are usually sufficient to gain good control. The sprays and dusts used with success against household cockroach species are of very limited benefit against roaches.

Exclusion techniques that prevent roach entry should be considered. Doors and windows should be tightfitting and cracks, gaps and other possible entry points should be sealed. If a breeding site can be moved or modified (e.g., relocating a wood pile farther from the house) it might help. Also, store firewood outdoors until you are ready to burn it. The males are attracted to lights at night and limiting porch light use in late May through June when males are flying might be of some benefit. Outdoor insecticide barrier treatments around windows and doors and along the foundation. Direct application of insecticide to firewood does no good and is discouraged. Cockroaches inside need only be picked up discarded.

### **Field Cockroach Chemical Control**

As breeding populations rarely become established indoors, house interiors should not be treated. Treat exteriors only when cockroaches enter homes from the surrounding environment.

Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair.

### **Boric Acid Control**

Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid.

Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application. The use of residual sprays or aerosol foggers within a structure is of little value in controlling cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy. Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.



## Florida Woods Cockroach (*Eurycotis floridana*) aka Skunk Roach



### FLORIDA WOODS COCKROACH

The Florida woods cockroach (*Eurycotis floridana*), or palmetto bug is a large species of cockroach, which usually grows to a length of 1½ inch to 2 inches. It is black in color, and has a wide, glossy body, and appears at first glance to be wingless, however it does have very short wings just beneath its head, which are useless for flying. The cockroach, when disturbed, often emits a strong, disagreeable odor, somewhat reminiscent of amaretto. The Florida woods roach looks remarkably similar to the female Oriental cockroach, and the two could be mistaken for each other by the casual observer.

The roach is slower moving than other species. It prefers damp locations, lots of moisture, and does well in warm, damp climates. It is found in its native habitats, such as Florida, and the West Indies. The roach can wander indoors at times, especially into damp locations, such as bathrooms; however, it is found mostly outdoors and is not considered a major pest in the home. It is cold intolerant and requires a warm, sub-tropical or tropical climate. It can often be seen in sheltered outdoor locations, such as under leaf litter, in tree holes, and under lumber and boards, and other crevices. It is often seen in bushes and wooded areas. Often it can be seen on Palmetto trees, which gave it one of its early popular names, the Palmetto bug. Florida woods cockroaches have only one generation per year. Adults may survive for several years.

The Florida woods cockroach is so named Asian cockroach because it's primarily found in Florida in wooded areas. The nymphs have broad yellow bands on the top of their thorax. The average egg-to-adult development is approximately 100-150 days, and females will produce 20-24 eggs per egg capsule.

Adults have a long lifespan, and have a high reproductive capacity. This species can reproduce without fertilization by a male. They feed on decaying organic matter.

The Florida woods roach is also known as the Florida stink roach or 'skunk roach' as it known to emit an oily, vile-smelling liquid from a single gland on the underside of its abdomen when disturbed and to protect it from predators. It is apparently ejected only backwards, and when placed in a closed container it may cause its own death due to this secretion.

### **Life Cycle**

Cockroaches have incomplete metamorphosis. Most species of cockroaches lay eggs in an ootheca (egg case) that is either deposited on or under suitable substrate, or carried attached to the genital region.

The egg stage lasts from a few weeks to a few months. The young are active from hatching and resemble the adults but are usually lighter in color and lack wings. The young cockroaches develop through a number of nymphal instars, which may range from 2 to 12 depending on the species and may take from a month or so up to 12 months to reach maturity. Some species may live for several years.



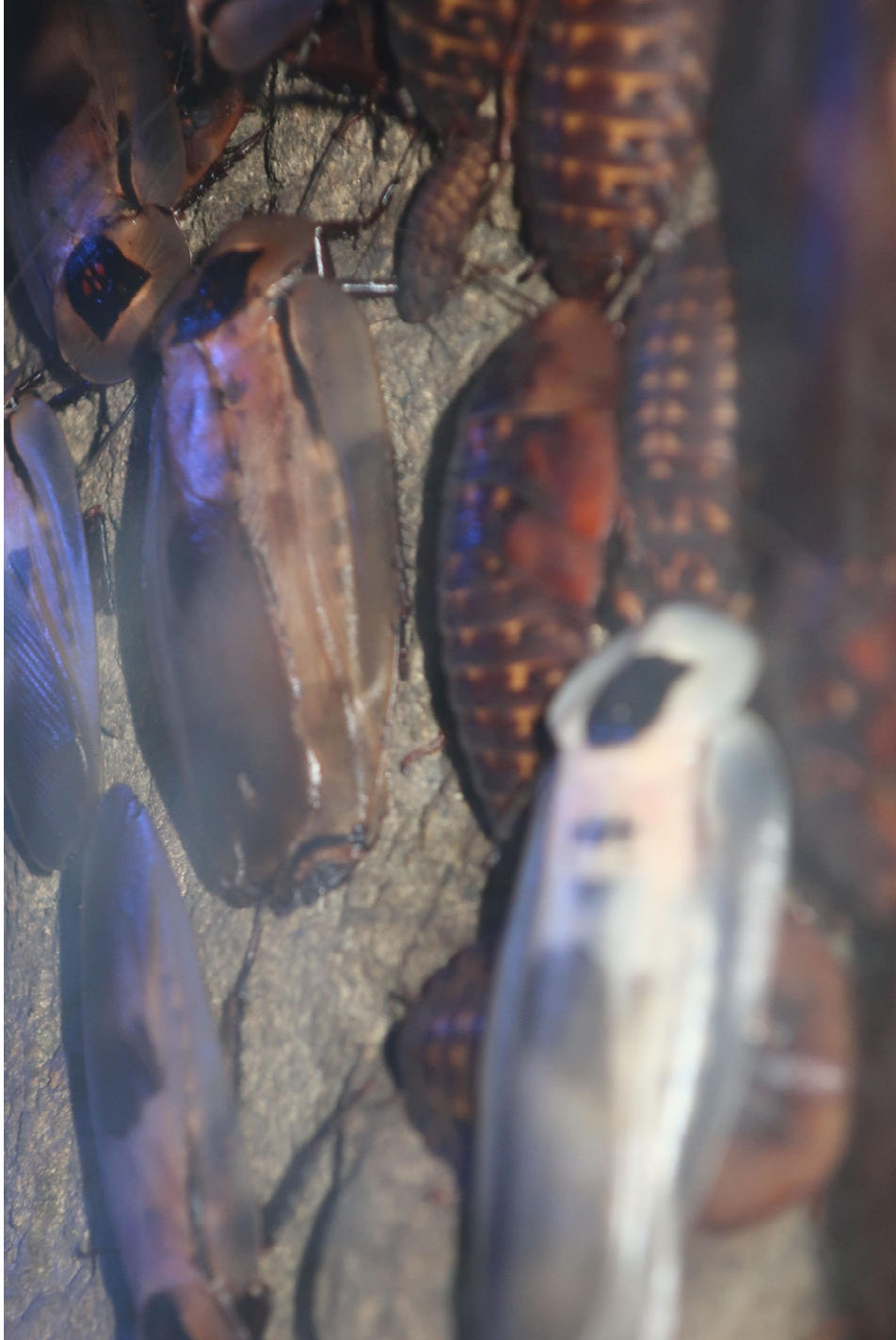
## Giant Cave Cockroach (*Blaberus giganteus*) - The Largest Roach



### GIANT CAVE COCKROACH LOOKS LIKE DEATH HEAD'S COCKROACH

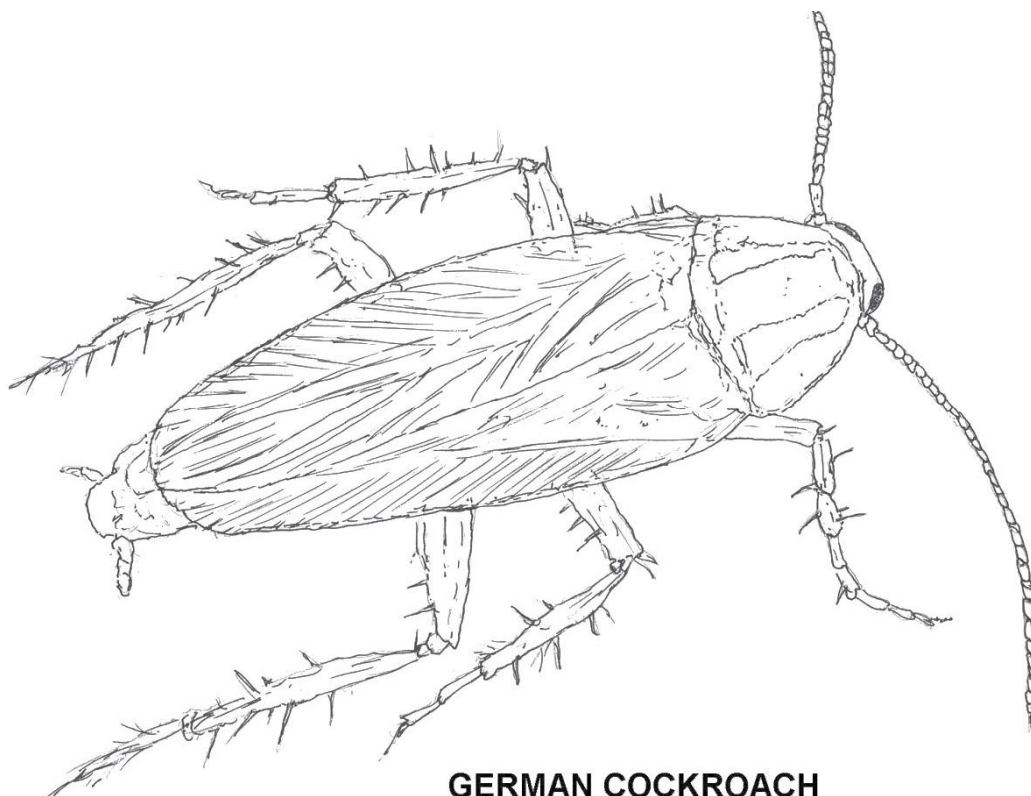
*B. giganteus* is considered one of the largest cockroaches in the world, with males reaching lengths of up to 7.5 cm (3.0 in) and females 10 cm (3.9 in), although others list 9 cm (3.5 in) as the maximum length. These cockroaches are lightly built with flattened bodies, allowing them to hide in cracks from predators. Their bodies are brown with black markings. The wingspan of these insects is usually around 15 cm (6 in). Both males and females bear paired appendages (cerci) on the last abdominal segment, but only the males have a pair of tiny hair-like appendages called styli.

Adults bear two phis species is endemic to Central America and northern South America, and can be found in the rainforests, in Mexico, Guatemala, Panama, Colombia, Venezuela, Brazil, Trinidad and Tobago, Guyana, Suriname, and French Guiana. Habitat preferences include areas of high moisture and little light, such as caves, tree hollows, and cracks in rocks. Pairs of wings folding back over the abdomen. The heavier females are less likely to fly. These incredible cockroaches are rare in the US. This is another roach species that people will keep as pets.



**Giant Cave Cockroach (*Blaberus giganteus*) - The Largest Roach**  
*Life size photo*

## German Cockroaches (*Blattella germanica*)



**GERMAN COCKROACH**

The German cockroach is the most common and the most difficult to control. Both adults and nymphs are light brown and have two longitudinal dark lines on their thorax (back). Adults are 1/2 to 3/4 inch long, and both males and females have wings as long as the body. Nymphs are similar in general appearance, but lack wings and may be as small as 1/8 inch.

The adult German cockroach is about 5/8 inch long, overall light brown in color with wings that cover the abdomen. The thoracic shield just behind the head (pronotum) is marked with two prominent black stripes. Immature stages (nymphs) are smaller, wingless and have a pale stripe (on at least the second and third thoracic segments in first stage nymphs) running lengthwise down the middle of the darker brown body.

The **field cockroach**, *Blattella vaga* Hebard, is similar to the German cockroach in appearance, but it occurs primarily outdoors where it feeds on decaying plant materials. Compared to the German cockroach, it is more active during daylight hours and will be found around lights. They also are known to fly when disturbed.

The **brownbanded cockroach**, *Supella longipalpa* (Fabricius) is about the same size as the German cockroach, but appear "**banded**" because the wings are marked with a pale brown band at the base and another about a third of the distance from the base.

### **Life Cycle**

Mated females produce an egg capsule that is attached to the end of the abdomen for up to a month before being dropped a day or so before eggs hatch. Each 5/16 inch long, brown egg capsule contains 30 to 40 eggs (oothecae) which hatch in 2 to 4 days after being deposited. Nymphs hatching from eggs are less than 1/8 inch long and wingless. They develop through 6 to 7 stages (instars) over 74 to 85 days (varying with temperature) before becoming adults. There may be four generations per year.

### **Habitat, Food Source(s), Damage**

This is mainly an indoor species, although they will also migrate outdoors from structure to structure. Occasionally, new infestations begin by bringing in cartons and other materials from infested structures that harbor the roaches or their eggs. Kitchens, bathrooms and other locations that provide food, moisture, warmth and shelter are preferred habitats. German cockroaches are mainly active at night, when they search for food and water.

During the day, they remain concealed in cracks and crevices unless they are over-crowded, with all developmental stages occurring together. They also can occur in attics, wall voids, crawl spaces, foundation cracks, garbage areas and around the landscape. May spread food contaminants and allergens. Some people have allergic reactions to cockroaches or cockroach residues (e.g., feces, body extracts).

### **Life Cycle and Biology of the German Cockroach**

Cockroaches have three life stages: egg, nymph, and adult. Each capsule contains 30-48 eggs. The nymphs shed their skins 5 to 6 times before they grow into adults. The adults have wings, which distinguish them from nymphs. It takes from 40 to 125 days for an egg to mature into an adult. Each adult female can produce 4 to 8 egg capsules. The adult cockroach can live up to a year. Cockroaches eat many kinds of materials. They are especially fond of starches, sweets, beer, and meat products.

They also feed on leather, bakery products, flakes of dried skin, dead animals, and plant materials. Cockroaches hide in dark narrow cracks and crevices. They tend to gather in corners (in the back of cabinets or drawers, for example) and generally travel along edges such as baseboards. They are most active during the night.

### **Pest Status**

One of the most common household cockroach pests in the U.S.; presence in homes is a nuisance and they may spread food contaminants. Some people have allergic reactions to cockroaches or cockroach residues (e.g., feces, body extracts).

The German cockroach has approximately six generations per year and each generation is completed in 50 to 60 days. The adult German cockroaches have a life expectancy of six months. This roach cannot fly but may glide very short distances if disturbed.

German cockroaches can live in almost any room of a home or building. Because these roaches require water, they prefer a warm moist environment, such as around kitchen and bathroom sinks, appliances, furnaces, water heaters and furnace ducts.

**Figure 1. German Cockroaches *Blattella germanica* (L.) with egg case**



A roach does not need heads to breathe -- they absorb oxygen through their bodies and can survive for a month without food. A headless cockroach will live for about a week until it dies of thirst.

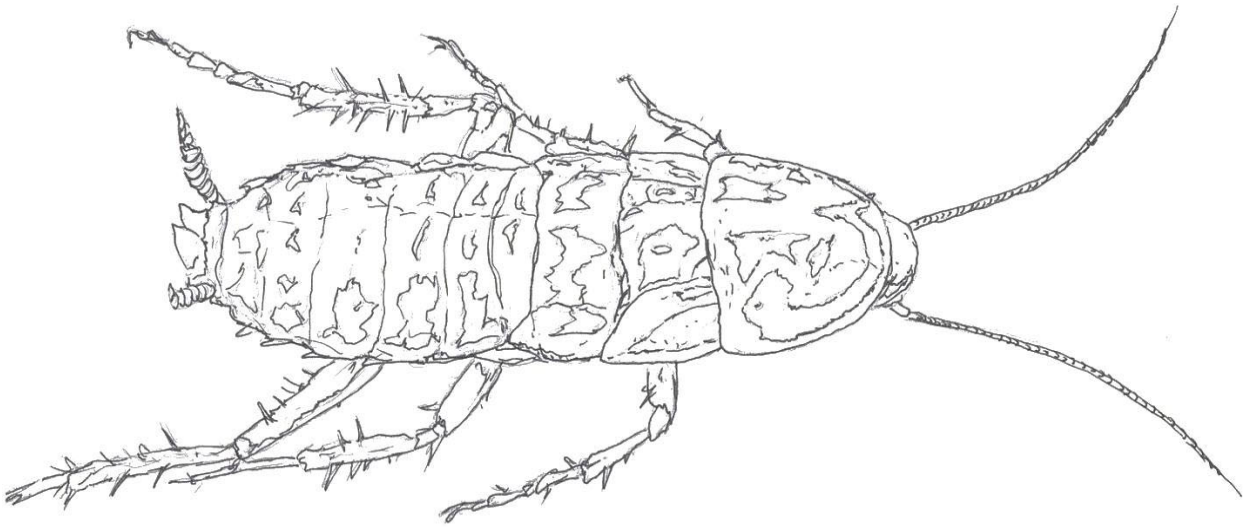
<b>Cockroach Heat Eradication Chart</b>	<b>Lethal Temperature</b>	<b>Duration Time</b>
German Adults	115° F	60 Minutes
German Adults	120° F	30 Minutes
German Adults	125° F	20 Minutes
German Adults	130° F	10 Minutes



The nearest relatives to cockroaches include mantids, grasshoppers, stick insects, and termites (Cornwell 1968).

*Life size photo*

**Harlequin Cockroach (*Neostylopyga rhombifolia*)**



### **HARLEQUIN COCKROACH**

The Harlequin roach is certainly among the neatest looking of the pet roaches and is a very quick moving medium sized species. Nymphs start out life as a plain tan color but slowly molt to become very incredible looking adults. Harlequin roaches easily scale smooth surfaces and like most other glass climbers can be controlled by petroleum jelly. Also, this roach is an egg laying species. Even though the harlequin cockroach has spread to various parts of the world, it is not considered to be a pest. There are very few reports of harlequin cockroaches invading homes in the United States.

The harlequin cockroach grows to be almost 10.5" long. The female produces an egg case, called an ootheca. The female carries the egg case for a few days before leaving it in a suitable area to hatch. In the immature, nymph stage, the roaches are tan-colored insects. As they grow the nymphs molt or shed their skin. Each time they molt, they develop more of the pattern of the adult roaches.

Both male and female harlequin cockroaches have very short front wings. Their back wings are absent altogether. Because of this, they do not fly. However, they can run very fast. Because of its colorful appearance, the harlequin cockroach is popular with people who keep cockroaches as pets. People who are thinking about raising these cockroaches are cautioned that, like many other roach species, the harlequin cockroaches are excellent climbers. Smooth vertical surfaces are not obstacles. They can easily climb out of glass containers where people keep them. Experienced cockroach keepers suggest applying a coating of petroleum jelly around the rim of the container to keep the roaches from climbing out and escaping.

An approach that integrates several strategies is required to deal with cockroaches, beginning with regular monitoring.

Only monitoring can give you the information needed to efficiently and effectively deal with the situation, i.e. which cockroach is present, how are they arriving (as invaders from outside, or in food supplied from a distributor), how many are there, and are they breeding - as indicated by the presence of both adults and nymphs?

Regular monitoring will let you know early on if you have cockroach invaders, and the problem can be dealt with before it becomes extensive.

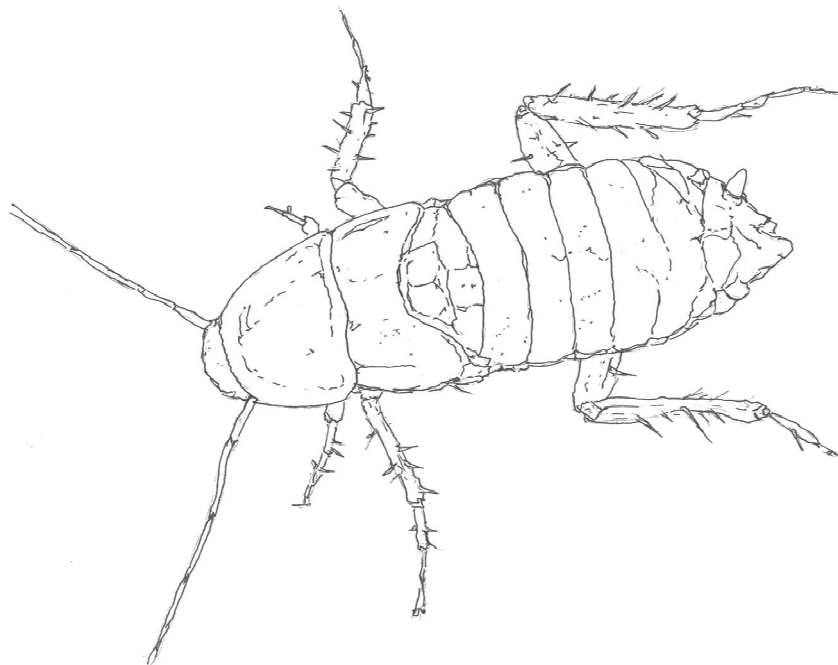
Some cockroaches do not move extensive distances. German cockroach nymphs will only move a few feet from where their egg case hatched. Finding nymphs in a monitoring trap indicates that you are exactly where the cockroaches are infesting; this is the location that needs to be cleaned, uncluttered, and possibly treated with a bait.

### **What do Cockroaches Feed on?**

Cockroaches feed on a wide variety of food (grease, crumbs, pet food, wax, gum, leftover food in empty food cans etc.). They also eat paper if it has glue on it, and some will feed on soap bars. Cockroaches can withstand long periods of starvation and can live for many days without water.

### **Do Cockroaches Transmit Disease?**

Cockroaches are scavengers. While walking on spoiled food in garbage containers, they pick up various bacterial organisms on their legs that they can later deposit on uncovered food. Cockroaches themselves are not implicated in the transmission of any diseases. However, many disease-causing organisms can grow and multiply in their guts and can then be deposited on silverware, plates etc. during defecation. For example, cockroaches can pick up disease-causing bacteria like Salmonella on their legs and later deposit them on foods and cause food poisoning. People continuously exposed to dust containing cockroach feces and crushed body parts become sensitized and may show allergic reaction and asthma after repeated exposure to such dust.



**TURKESTAN COCKROACH**



## Madagascan Giant Hissing Roaches (*Gromphadorhina portentosa*)



### MADAGASCAN GIANT HISSING ROACH - PET

The cockroach family, to which Madagascan roaches belong, is among the most primitive of the winged insects, and yet is a highly designed creature. The nearest relatives to cockroaches include mantids, grasshoppers, stick insects, and termites (Cornwell 1968). The fossil record shows that roaches were very abundant during the Carboniferous period. There are at least 3,500 known species living today, in 450 genera, most of which originate in the tropics.

As a group, cockroaches exhibit a wide diversity of sizes, colors, and habits. Although they have an infamous reputation as household pests, in reality only about half a dozen species (less than one percent of all known forms) have negative associations with humans. Many species are diurnal, some are semiaquatic, and others live in the ground or are wood-boring. Some, such as the Madagascan roach, do not have wings. About a dozen or so species live commensally in the nests of ants, wasps, or termites. There are also roach species that inhabit caves with bats or live in the desert. The majority of cockroaches in tropical countries exist as scavengers outdoors, feeding on vegetation and organic matter in an apparently harmless fashion.

#### **Did you know that these creatures are immune to Cobra venom?**

The toxicity of the Thailand and Middle-Asian cobra venoms as well as of their isolated components (neurotoxins, cytotoxins, phospholipases and some others) for cockroach *Gromphadorhina portentosa* was studied. It was found that, as compared to mammals, cockroaches are more resistant to cobra venoms and their components.



***Nothing as nice as a jeweled cockroach.*** This would be a nice gift for any pesticide sprayer's wife. We are thinking that humans have lost their minds that we must have cockroaches as jewelry or as pets. It was widely reported that Oprah Winfred once had cockroaches as pet because she was very poor as a youth. I guess, now she can afford diamond encrusted cockroaches as pets. I know some of you out there will eat a big cockroach for dinner tonight. You might call it a crustacean instead, but we know it is really a big fat juicy cockroach from the sea.



Only the Giant Cave Cockroach is larger in size. The problem with Cave Roaches is that they prefer dark locations while the Madagascan roaches can live with normal daylight. Both are considered pets in the US and are sold at pet stores. I have seen cages filled with both species and people treating these creatures like normal pets - like a dog or cat.

## Oriental Cockroach (*Blatta orientalis*)

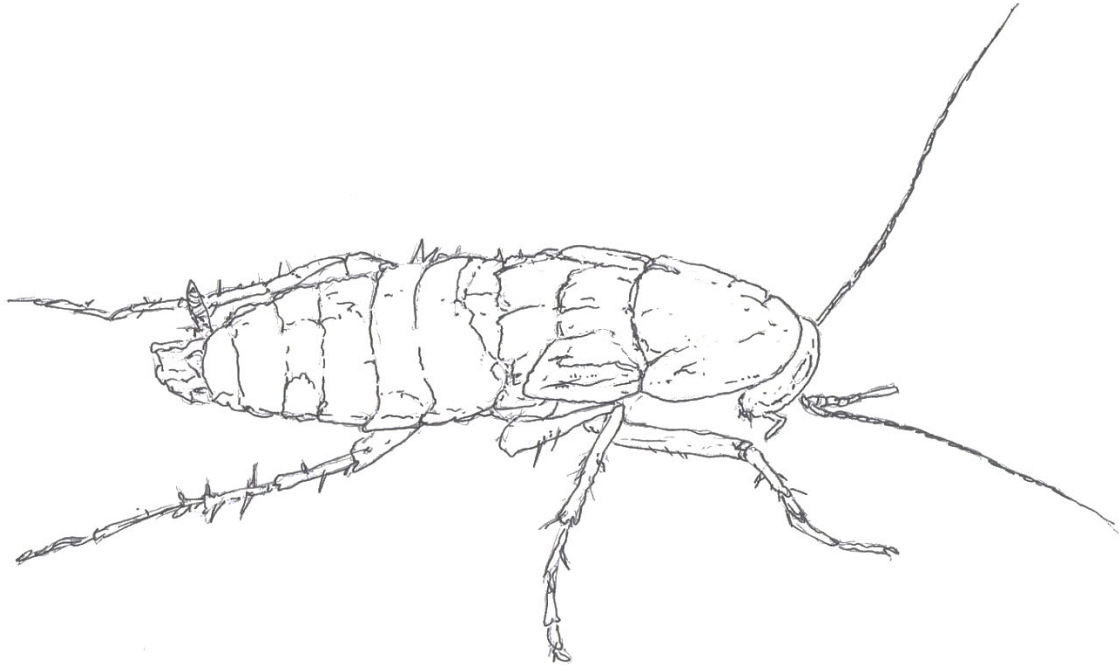


### ORIENTAL COCKROACH

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

Neither males nor females can fly or glide. The female carries an egg capsule for about 30 hours and then drops or attaches it to a protected surface near food. On average, a female produces eight egg capsules, each containing 16 eggs which hatch within 60 days. The reproductive cycle of this roach is completed in 6 to 9 months.

Oriental roaches prefer damp, cool, dark areas. They are generally found in sewer drains, crawl space areas, basements, cellars, or on the first floor of buildings. Infestations by this roach are most frequently found during spring (April and May) and fall (October). They may spend considerable time outdoors during warm weather.



## ORIENTAL COCKROACH

*Blatta orientalis* is common outdoors, and lives in warm damp shady areas near the ground or any area containing natural debris. It will often seek refuge indoors when a drop in temperature occurs, but is still quite tolerable of cooler weather. The most common areas to find *B. orientalis* are basements, crawl spaces, areas between the soil and foundation, underneath sidewalks, in sewer pipes, in floor drains, and under sinks or any other damp cool area in the house. The roach travels through the structure on plumbing pipes.

Outside the house they sometimes aggregate near or under garbage cans. The species tends to be seasonal, with adults appearing in spring and summer. When large numbers of roaches occur, overcrowding can lead to the mass migration of roach species such as the German cockroach, *Blattella germanica*, the American cockroach, *Periplaneta americana*, and the oriental cockroach. The origin of the oriental cockroach, *Blatta Orientalis* Linnaeus, is uncertain, but it is thought to be from Africa or south Russia. It is a major household pest in parts of the northwest, mid-west, and southern United States. It is also sometimes referred to as the "black beetle" or a "water bug" because of its dark black appearance and tendency to harbor in damp locations.

### Three Developmental Stages

The Oriental cockroach has three developmental stages: egg, nymph, and adult. Eggs are laid in capsules, which the female carries for about 30 hours and then drops onto a protected surface near a food supply. The female does not glue the egg capsule to the surface. An adult Oriental cockroach is about 1 to 1-1/4 inches long and dark brown, almost black. A male has fully developed wings which are shorter than the body. A female has very short, rudimentary wings (fig. 3). A nymph is similar in appearance to a female only it is smaller and wingless. A female deposits an average of eight egg cases during its lifetime; each capsule produces about 16 young. It takes 300 to 800 days, depending on conditions, for Oriental cockroaches to hatch from eggs and develop into adults.

### **Oriental Cockroach Damage**

Oriental cockroaches feed on all kinds of filth, rubbish, and other decaying organic matter. They seem especially fond of garbage and the contents of discarded tin cans. If water is available, they can live for a month without food; without water they die within two weeks. The most important aspect of cockroach damage derives from their habit of feeding and harboring in damp and unsanitary places such as sewers, garbage disposals, kitchens, bathrooms, and indoor storage areas. Filth from these sources is spread by cockroaches to food supplies, food preparation surfaces, dishes, utensils, and other surfaces. Cockroaches contaminate far more food than they are able to eat.

### **Odorous Secretions**

Cockroaches in general produce odorous secretions from various points in their bodies. Such secretions can affect the flavors of various foods. When cockroach populations are high, these secretions may result in a characteristic odor in the general region of the infestation. Disease-producing organisms such as bacteria, protozoa, and viruses have been found in their bodies. Different forms of gastroenteritis (food poisoning, dysentery, diarrhea, etc.) appear to be the principal diseases transmitted by Oriental cockroaches. The insects carry these disease-causing organisms on their legs and bodies and deposit the organisms on food and utensils as they forage. Cockroach excrement and cast skins also contain a number of allergens, to which many people exhibit allergic responses such as skin rashes, watery eyes, congestion of nasal passages, asthma, and sneezing.

### **Management**

Survey - To control Oriental cockroaches, it is important to do a thorough inspection. A cockroach survey (trapping) is sometimes necessary to determine the extent of an infestation, because even a thorough inspection will not reveal all cockroach harborages or areas where they forage most actively at night. Surveys are particularly useful in houses and buildings where there is a moderate to heavy level of infestation. Cockroach surveys involve placing sticky traps at strategic locations within the building. Whenever possible place survey traps either against a wall or in a corner of the floor. Most commercially available traps come complete with bait to encourage cockroaches to enter. One week of trapping at a sufficient number of trapping sites usually provides enough information for more complete and effective control.

### **Sanitation, Structural Modifications, and Repairs**

Modifying the interior environment—removing food, moisture, and harborages for cockroaches—is the first step in treatment. Eliminating cockroach harborages involves caulking in closets and cabinets, caulking under the sink, etc., or making similar structural repairs in the kitchen, bathroom, and other areas of the house.

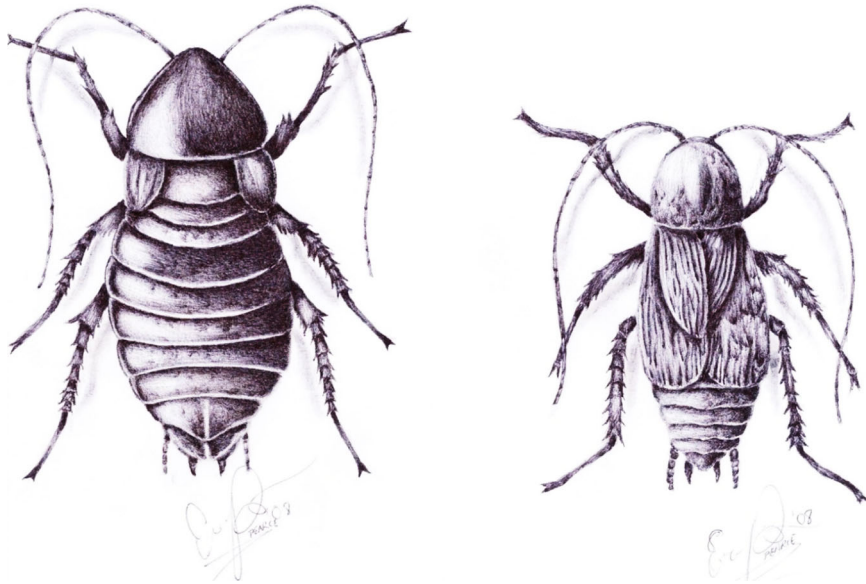
### **Move into Dwellings**

Oriental cockroaches may move into dwellings from the outside. Recent research has been conducted on the movement of Oriental cockroaches under, around, and into homes from harborages in crawl spaces and cinder block foundations. The research has shown that these cockroaches frequently move into the home along plumbing (e.g., up through the floor from underneath the crawl space) and under door or window jams. The use of screening, caulking and similar items may be useful in tightening the exterior to deter entry by the cockroaches.

### **Chemical Control**

Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of Oriental cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application.

The use of residual sprays or aerosol foggers within a structure is of little value in controlling Oriental cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy. Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.



**ORIENTAL COCKROACH**

## **Palmetto Bug AKA American Cockroach**

There is no difference between a cockroach and a palmetto bug. The cockroach is also known as the waterbug, Croton bug and palmetto bug. Originally from tropical Africa, cockroaches are thought to have been brought to North America aboard slave ships. Today, they are found thriving across the globe.



### **AMERICAN COCKROACH AKA PALMETTO BUG**

Palmetto bugs are reddish-brown in color and are considered large insects, sometimes exceeding 1.5 inches in length. Some cockroach species have wings, although most are incapable of flight. Adult cockroaches have shiny bodies with yellow margins behind the head. Male and female cockroaches are typically approximately the same size and appear similar.



### **WOOD COCKROACH – LOOKS LIKE AMERICAN COCKROACH**

Both have a pair of cerci at the tip of the abdomen, although only males have styli. Many would say that a flying cockroach is about as awful a thing the animal kingdom could produce, but to add to their mystique, the Palmetto Bug is also quite fast. In fact, in 1991 a research experiment was carried out at the University of California at Berkeley and a registered record speed of 3.4mph was one of the most astonishing results. Based on body size, this could be comparable to a human running 205 mph (330kph).

### **Chemical Methods for Palmetto Bug/American Cockroach Control**

#### **Dust Cracks & Crevices**

- The dusts that work best against Palmetto Bugs are Delta Dust and CB Borid Boric Acid.
- Using a hand duster and following label instructions, apply dust liberally where roaches travel--underneath and behind baseboards, behind wall outlets, in wall voids, in cupboards and cabinets, and underneath appliances such as washers and dryers.

#### **Apply a Liquid Residual to the Perimeter**

- Demand CS, Suspend SC, or Demon WP provides excellent control when mixed in a 2 gallon sprayer and applied at a low-pressure setting.
- Spray indoors along baseboards, especially in corners; window and door frames, on the underside of furniture, behind bookshelves, and in other problem areas as listed on the product label. With Palmetto bugs, the other perimeter of the home or structure should also be treated.
- Residual sprays need to be reapplied every month to every 3 months, depending on the level of infestation.

#### **Baits**

- Use Niban FG in attics, basements, and crawlspaces where Palmetto Bugs enter, and for added protection, spread DeltaGard G Granules outdoors in pine straw and mulched areas surrounding the infested structure.

#### **Contact Killers**

Contact sprays will kill roaches immediately on contact, and can also be used to "flush out" roaches from suspected harborages. Contact Sprays for Palmetto Bugs/American cockroach include CB-80 Extra, Cy-Kick, D-Force HPX, 565 Plus XLO.

#### **IGR**

An IGR is a chemical used to disrupt and impede the life cycle of insects in the egg and larvae stage of development. The idea with an IGR is that if an insect cannot reach adulthood, it cannot reproduce. In short, IGR is a form of "birth control" for Palmetto Bugs and other pests, which helps to keep populations under control by preventing current and future infestations.

- The most common and effective IGR for roach control is Gentrol IGR, which comes in an aerosol, concentrated liquid, and point-source tablet.
- We recommend Gentrol IGR Concentrate to be added to your hand sprayer and sprayed right along with your baseboard chemical (Demand CS, Suspend SC, or Demon WP).
- For kitchen and bathroom areas, Gentrol Aerosol is the formulation of choice. Using the straw attachment, the IGR should be applied liberally to all visible cracks and crevices, including underneath, behind, and alongside appliances, behind



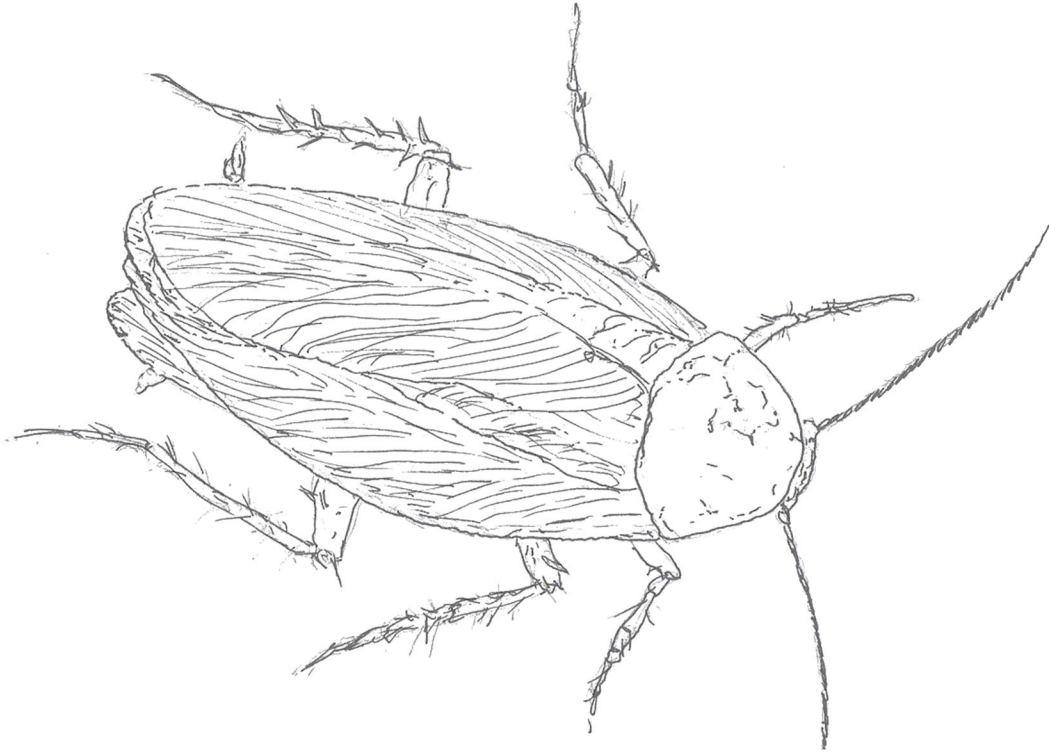
- outlets, along pipe collars, inside wall voids, and on top of kitchen cabinets near the ceiling.
- Continue to apply IGR every 4 to 6 weeks for up to 6 months, or until all signs of infestation have been eliminated.



**AMERICAN COCKROACH HEAD**



**WESTERN WOOD COCKROACH**



**SMOKY-BROWN COCKROACH**

## **Sand Cockroach**

As their name implies, sand cockroaches are found near deserts and sand hills. Sand cockroaches live in sand dunes for most of the year and burrow deep within the soil in winter. Sand cockroaches eat the roots of desert shrubs, which also serve as their main source of water. Small ridges left in the sand indicate their presence. Sand cockroaches are nocturnal and adult females remain inside their burrows for most of the day in order to avoid sunlight.



### **SAND COCKROACH**

Female sand cockroaches resemble trilobites more than they do other cockroach species: they are black, wingless and oval-shaped. Male sand cockroaches are dusty-brown in color. The females are wingless. Although it is rare, sand cockroaches do sometimes enter human dwellings. This species does not cause harm to humans and will not breed inside your home. However, they can be difficult to eradicate.



### **BOLL'S SAND ROACH**

An approach that integrates several strategies is required to deal with cockroaches, beginning with regular monitoring. Only monitoring can give you the information needed to efficiently and effectively deal with the situation, i.e. which cockroach is present, how are they arriving (as invaders from outside, or in food supplied from a distributor), how many are there, and are they breeding - as indicated by the presence of both adults and nymphs?

Regular monitoring will let you know early on if you have cockroach invaders, and the problem can be dealt with before it becomes extensive. Some cockroaches do not move extensive distances. German cockroach nymphs will only move a few feet from where their egg case hatched. Finding nymphs in a monitoring trap indicates that you are exactly where the cockroaches are infesting; this is the location that needs to be cleaned, uncluttered, and possibly treated with a bait.

#### **Exterior Treatments**

Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair. Changing white incandescent bulbs to yellow bulbs around entrance doors may help.

### **Chemical Control**

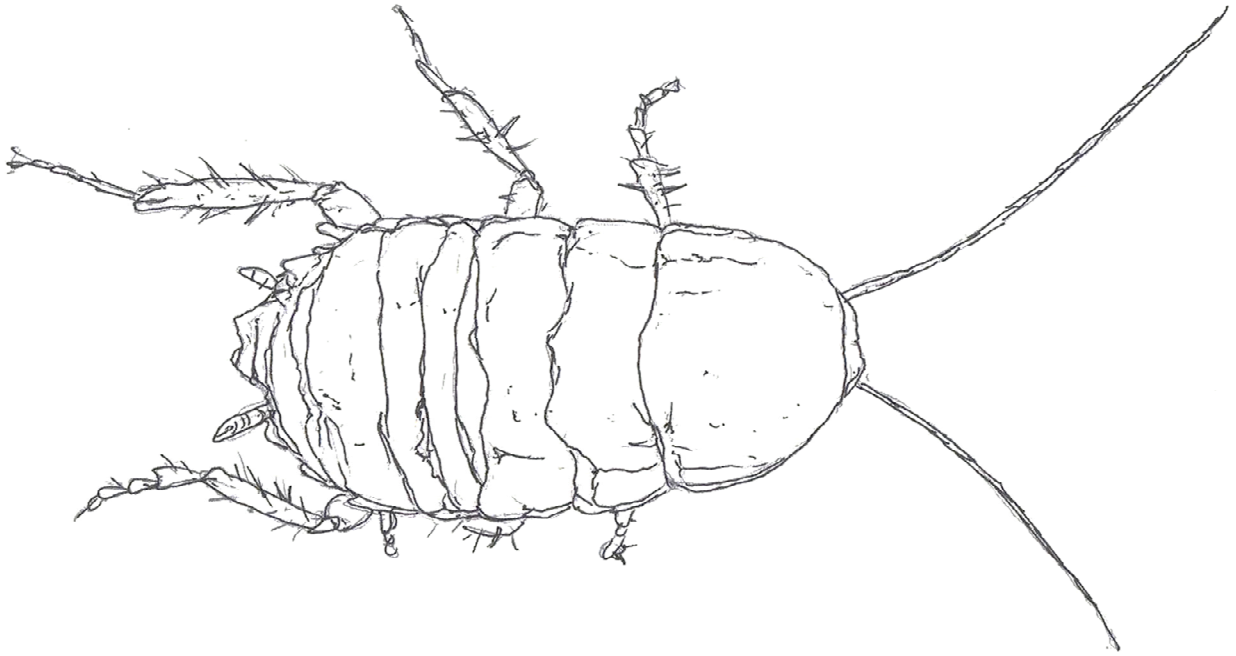
Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them.

Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior.

Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application. The use of residual sprays or aerosol foggers within a structure is of little value in controlling cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy. Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.



## Skunk Roach AKA Florida Roach (*Eurycotis floridana*)



### SKUNK COCKROACH

**Adult size:** 24-40mm (1 to 1 and 3/4 inches).

This adult is by far the largest of the egg laying species commonly kept and the egg cases are huge too. The background color of *E. floridana* is a strange maroon. In nearly all culture stocks, the medium-sized nymphs have yellowish margins along the sides of the thoracic segments but the adults are always completely maroon. There is also a rare culture stock from the Keys in which the adults retain the nymphal striping. 1st instar nymphs of this species are oddly able to (slowly) walk right over Vaseline so a sealed container is necessary.

#### **Odorous Secretions**

Cockroaches in general produce odorous secretions from various points in their bodies. Such secretions can affect the flavors of various foods. When cockroach populations are high, these secretions may result in a characteristic odor in the general region of the infestation. Disease-producing organisms such as bacteria, protozoa, and viruses have been found in their bodies. Different forms of gastroenteritis (food poisoning, dysentery, diarrhea, etc.) appear to be the principal diseases transmitted by Oriental cockroaches. The insects carry these disease-causing organisms on their legs and bodies and deposit the organisms on food and utensils as they forage. Cockroach excrement and cast skins also contain a number of allergens, to which many people exhibit allergic responses such as skin rashes, watery eyes, congestion of nasal passages, asthma, and sneezing.

## **Management**

Survey - To control Skunk cockroaches, it is important to do a thorough inspection. A cockroach survey (trapping) is sometimes necessary to determine the extent of an infestation, because even a thorough inspection will not reveal all cockroach harborages or areas where they forage most actively at night.

Surveys are particularly useful in houses and buildings where there is a moderate to heavy level of infestation. Cockroach surveys involve placing sticky traps at strategic locations within the building. Whenever possible place survey traps either against a wall or in a corner of the floor. Most commercially available traps come complete with bait to encourage cockroaches to enter. One week of trapping at a sufficient number of trapping sites usually provides enough information for more complete and effective control.

## **Sanitation, Structural Modifications, and Repairs**

Modifying the interior environment—removing food, moisture, and harborages for cockroaches—is the first step in treatment. Eliminating cockroach harborages involves caulking in closets and cabinets, caulking under the sink, etc., or making similar structural repairs in the kitchen, bathroom, and other areas of the house.

## **Chemical Control**

Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid.

Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of Skunk cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application.

The use of residual sprays or aerosol foggers within a structure is of little value in controlling Skunk cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy. Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.



## Smokybrown Cockroach (*Periplaneta fuliginosa*)



### SMOKYBROWN COCKROACHES

The adult is slightly more than 1-inch-long and is a uniform, very dark brown to black. The head shield is a solid dark color. Both males and females have wings longer than their bodies and are capable of flying or gliding. Nymphs are smaller than adults and have only partially developed wings.

Adult females usually carry their egg capsules for a day or two before attaching them to the outside surfaces of buildings and other protected sites near the ground. These cockroaches live primarily outdoors and prefer wood, leaf litter, trash piles and other humid sites with abundant organic matter. They also hide under rocks, ground cover and building materials. They may enter homes with infested firewood during seasonal migrations. The smokybrown cockroach is closely related to the American cockroach, but is a uniform shiny, dark-brown or mahogany color. It is about 1 1/4 to 1 3/8 inches long and the wings of both sexes cover the abdomen. The female has a broader abdomen than the male and lacks styli. Young nymphs have white markings on the thorax and abdomen, and on some antennal segments.

Older nymphs are uniformly dark brown. Smoky-brown cockroaches require high humidity for survival. They are found outside in wooded areas that provide shade and moisture. They can also be seen in protected areas around homes (tree holes and mulch) and in buildings and attics. Stacks of lumber and firewood, sewer-access openings and trash piles can contribute to infestations. Once in structures they are commonly found in attics or near fireplaces. These cockroaches can be attracted by a leaky roof.

The smokybrown cockroach, *Periplaneta fuliginosa*, is usually found in decorative plantings and planter boxes, woodpiles, garages, and water meter boxes; it may occasionally inhabit municipal sewers. They sometimes invade homes, taking refuge in areas such as the attic. Nymphs are dark brown and have white segments at the end of their antennae and across their backs. Smokybrown cockroaches prefer the upper parts of buildings; they also may live under shingles or siding and sometimes get into trees, shrubs, and other vegetation during summer months. Females carry the dark brown to black egg case, which measures about 3/8 inch long, for about 1 day before dropping it; eggs can quickly hatch in 24 days or take 70 days after being laid, depending on temperature. About 40 to 45 nymphs hatch from a single egg case.

### **Outside Living**

Because the smokybrown cockroach is found outdoors, applications of insecticides to foundation plantings, wood piles, mulch, and other infested locations are recommended. Treatments placed to intercept cockroaches are both environmentally- and entomologically-sound. Residual barrier sprays have been shown to provide substantial reductions of smokybrown cockroach populations around houses. Power dusting of sewage lines, crawl spaces, false ceilings, wall voids, and trash chutes is an effective method of control. Space sprays, ULV treatment, or contact aerosols and sprays can be used in basements and utility rooms. Loose baits and other formulations better suited for damp locations can provide effective control in basements and similar areas.

### **Habitat**

The Smokybrown cockroach has a great tendency to lose moisture through the cuticle and thus requires water every two to three days. These requirements are important to remember when implementing your roach extermination program.

This pest is most likely found in areas which are protected, moist, dark, relatively warm and free from the desiccating effects of air flow. In nature, tree holes and the canopies of palm trees offer the ideal environment in which this bug can thrive. The home equivalent of these conditions includes:

- Block Walls
- Flower Beds
- Any Mulched Areas
- Attics or Soffits with Moisture Problems
- Damp Basements
- Any Dark, Poorly Ventilated Area

### **Chemical Control Methods**

The same treatment techniques that apply to carpenter ants can be used on acrobat ants. Finding and treating their colonies in wall voids and wood can usually control these ants.

Drilling small holes and dusting the infested areas with insecticide dusts can effectively treat infested walls and voids that harbor these ants. All colonies found outside should be treated directly with a liquid contact spray. Perimeter and foundation treatments of structures with a liquid insecticide will help prevent outdoor foraging ants from entering.

Spray applications to trees where Acrobat Ants are located are helpful. An approach that integrates several strategies is required to deal with cockroaches, beginning with regular monitoring.

Only monitoring can give you the information needed to efficiently and effectively deal with the situation, i.e. which cockroach is present, how are they arriving (as invaders from outside, or in food supplied from a distributor), how many are there, and are they breeding - as indicated by the presence of both adults and nymphs?

Regular monitoring will let you know early on if you have cockroach invaders, and the problem can be dealt with before it becomes extensive.

Some cockroaches do not move extensive distances. German cockroach nymphs will only move a few feet from where their egg case hatched. Finding nymphs in a monitoring trap indicates that you are exactly where the cockroaches are infesting; this is the location that needs to be cleaned, uncluttered, and possibly treated with a bait.

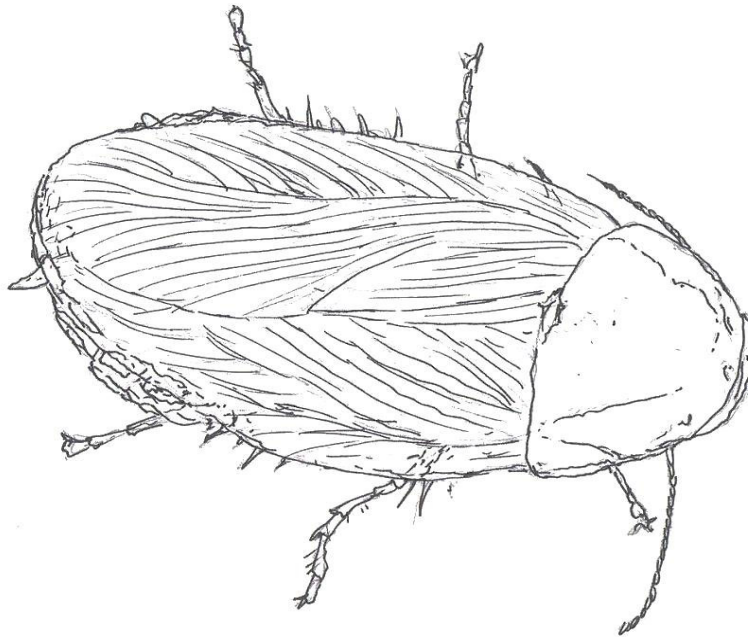
### **Control Smokybrown Cockroaches**

1. Eliminate or alter any conditions which encourage the presence and/or reproduction of the roaches. These pests thrive in dark, humid areas which have little or no air flow.
2. Spray exterior of structure with Suspend SC, Demon WP or Cynoff WP. These odorless insecticides will give a quick knockdown of bugs while lasting for several weeks, usually yielding about a 90 day residual. Spray any crack, crevice or entry point on the outside of the structure. This includes treating around all windows, doors, vents and in weep holes of brick veneer. Also spray tree trunks, from ground to crotch of tree, but no higher than six feet. All mulched areas should be sprayed with insecticide. These exterior surfaces should be treated 3 to 4 times each year.
3. If necessary, spray indoors in the following areas: basements, garages, carports, attics, closets, laundry rooms. Also treat beneath and behind large appliances (refrigerators, stoves, etc.) or other areas where these roaches prefer to hide. (Spraying all of your baseboards with any bug spray is not necessary!) Indoor areas should be treated 2 to 3 times per year.
4. Hollow blocks or other areas such as behind brick walls and along plumbing lines should be treated with Delta Dust. Although many dusts will kill roaches, Delta Dust is water-proof and will not be destroyed by the moist habitat of the Smokybrown as would other dusts. For deeper penetration and better distribution of insecticide dust, use a Crusader Duster. Delta Dust should be used once each year or as needed.



**PENNSYLVANIA WOODS COCKROACH**

## Surinam Cockroach (*Pycnoscelus surinamensis*)



### **SURINAM COCKROACH**

The Surinam cockroach is a species of cockroach. It is approximately 3/4" in length, with uniformly dark brown wings, and a shiny dark brown or black head and pronotum (the shield behind its head).

The Surinam cockroach is reported around the world in the humid tropics and in the U.S. from Texas, Louisiana and Florida. It is a burrowing insect which is capable of destroying various plants and is often brought into homes, shopping malls, restaurants in potted plants. Although this cockroach is not in the strict sense a household pest, it is nevertheless a source of much annoyance in related structures such as greenhouses. This species lives primarily outdoors and is considered a nuisance pest, as it does not breed inside homes. It can appear in northern states, usually in shopping malls and zoos, where it is found in atriums and potted plants carried from nurseries in Florida and other southern states. In the South, the Surinam cockroach can build large populations around structures in landscape beds where thick mulch layers, heavy ground cover and landscape timbers are present. This species does not fly. The females reproduce parthenogenetically without mating with a male. Surinam cockroaches are 3/4" to 1" long, are brown in color, and have a very obvious dark brown to black shield, (the area behind its head), which is called the pronotum.

Cockroaches are scavengers. While walking on spoiled food in garbage containers, they pick up various bacterial organisms on their legs that they can later deposit on uncovered food. Cockroaches themselves are not implicated in the transmission of any diseases.

However, many disease-causing organisms can grow and multiply in their guts and can then be deposited on silverware, plates etc. during defecation. For example, cockroaches can pick up disease-causing bacteria like Salmonella on their legs and later deposit them on foods and cause food poisoning. People continuously exposed to dust containing cockroach feces and crushed body parts become sensitized and may show allergic reaction and asthma after repeated exposure to such dust.

### **Control**

To control this insect it is critical to remove harborage areas, such as excessive leaf litter, excessive mulch, unneeded landscape timbers, stones, or other objects close to the foundation of your building. Residual materials should be applied to foundations, plantings, woodpiles, potted plants, mulch and any infested areas. Barrier treatments can substantially reduce Surinam cockroach populations around your home. An approach that integrates several strategies is required to deal with cockroaches, beginning with regular monitoring. Only monitoring can give you the information needed to efficiently and effectively deal with the situation, i.e. which cockroach is present, how are they arriving (as invaders from outside, or in food supplied from a distributor), how many are there, and are they breeding - as indicated by the presence of both adults and nymphs? Regular monitoring will let you know early on if you have cockroach invaders, and the problem can be dealt with before it becomes extensive. Some cockroaches do not move extensive distances. German cockroach nymphs will only move a few feet from where their egg case hatched. Finding nymphs in a monitoring trap indicates that you are exactly where the cockroaches are infesting; this is the location that needs to be cleaned, uncluttered, and possibly treated with a bait.

### **Exterior Treatments**

Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair. Changing white incandescent bulbs to yellow bulbs around entrance doors may help.

Common names (the names found on the list of active ingredients) of other effective pesticides include: propoxur (Baygon), cyfluthrin, permethrin, deltamethrin, and tetramethrin. A variety of formulations may be available, including sprays (liquid or wettable powders), aerosol sprays, baits or dust. No single chemical or formulation will control all cockroaches. Some German cockroach infestations are resistant to one or more insecticides. Apply insecticides only to cracks, crevices, or unexposed surfaces, and not beyond the point of runoff. Avoid spraying carpets, wallpapers, or other furnishings that might be stained.

### **Chemical Control**

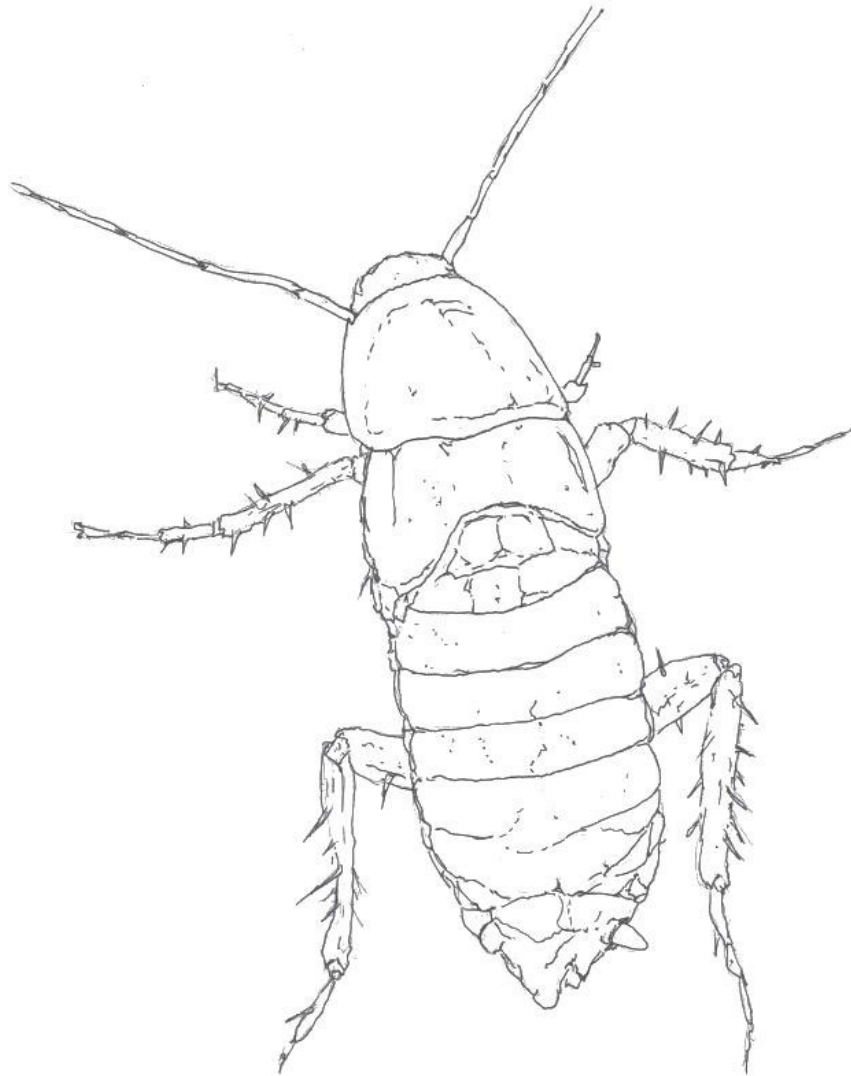
Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food.

Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application. The use of residual sprays or aerosol foggers within a structure is of little value in controlling cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy.

Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

**NOTE:** When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.



**TURKESTAN COCKROACH**



## **Turkestan Cockroach (*Blatta lateralis*)**

The Turkestan cockroach is a new cockroach to this country, and it is spreading. It was first seen in 1978 at a military base in Lathrop, California. Apparently it was a stow-away in household goods brought back from the Middle East. It has now also been reported in Arizona and Texas, and could eventually spread throughout much of the Southern United States.



### **TURKESTAN ROACH -FEMALE**

A recent report shows that the Turkestan roach is now infesting schools in Los Angeles. Sometimes they are so numerous that custodians report it is difficult to walk the grounds on hot summer nights without stepping on them. These roaches live primarily outdoors and in sewers, but come indoors when it is dry, searching for moisture. Male and female Turkestan roaches look very different from each other. The males are easily mistaken for American cockroaches, and the females look very similar to Oriental cockroaches.

The male has long, yellowish-tan wings, they are usually found inside as they are attracted to lights and enter via poorly sealed doorways. The adults of this species grow to about 1" in length, with the female being a bit longer. The males are brownish yellow in color and the females are dark brown to black in color. The wings of the male extend beyond the abdomen whereas the female wings are very short triangular pads separated by less than a wings width. The nymphs (young) are bi-colored with the thorax (front) being light brown and the abdomen being dark brown. The ootheca or egg capsules are 3/8 to 1 "long, dark brown and contain about 18 eggs.

The female has short, rounded wings with creamy stripes along the edges and a pear-shaped body. This roach is typically found outdoors, but when it reaches peak populations in June, can be found indoors. This cockroach is not known to transmit disease, and is considered a beneficial decomposer in gardens and yards. Turkestan Cockroach prefers semi-arid to arid desert areas, in water meter boxes, cracks between blocks of poured concrete, compost piles, leaf litter, potted plants, and sewer systems.

## **Biology**

Not a lot is known about this species other than nymphal development takes around 118-137 days, and adults live from 30 to 300 days.

## **Control**

Controlling this roach is normally straightforward and fairly simple. Desiccant dusts and a good baiting system are usually sufficient to gain good control. The sprays and dusts used with success against household cockroach species are of very limited benefit against roaches. Exclusion techniques that prevent roach entry should be considered. Doors and windows should be tightfitting and cracks, gaps and other possible entry points should be sealed. If a breeding site can be moved or modified (e.g., relocating a wood pile farther from the house) it might help.

Also, store firewood outdoors until you are ready to burn it. The males are attracted to lights at night and limiting porch light use in late May through June when males are flying might be of some benefit. Outdoor insecticide barrier treatments around windows and doors and along the foundation. Direct application of insecticide to firewood does no good and is discouraged. Wood cockroaches inside need only be picked up discarded.

## **Chemical Control**

As breeding populations rarely become established indoors, house interiors should not be treated. Treat exteriors only when cockroaches enter homes from the surrounding environment.

Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair.

## **Exterior Treatments**

Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

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Window screening must be kept in good repair. Changing white incandescent bulbs to yellow bulbs around entrance doors may help.

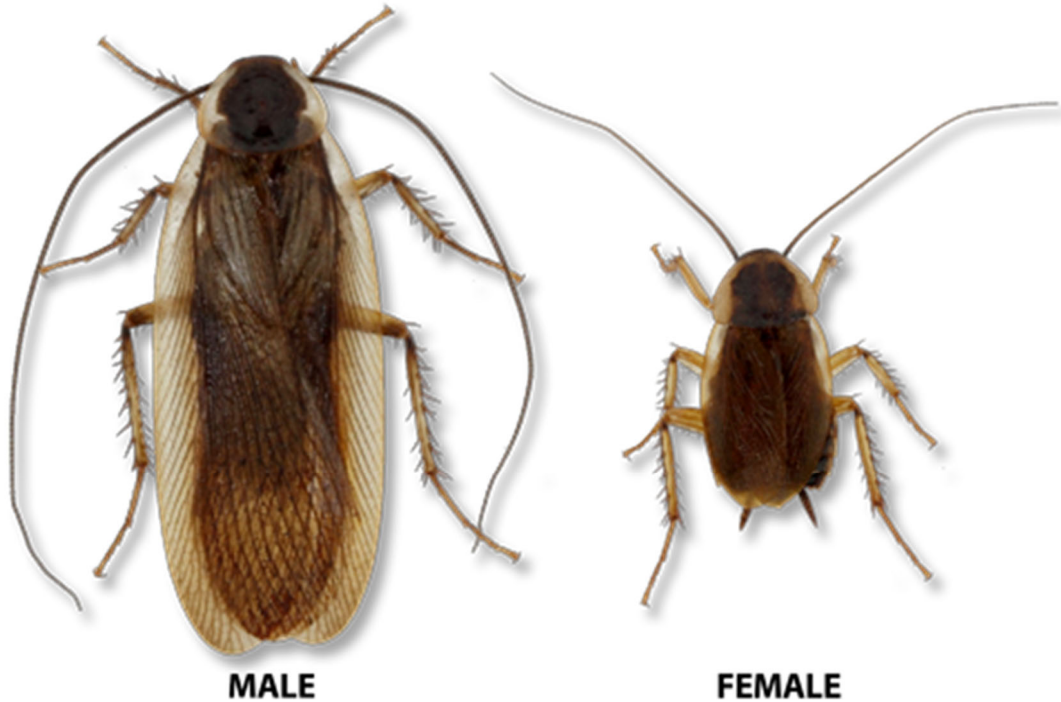
### **Chemical Control**

Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food.

Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application. The use of residual sprays or aerosol foggers within a structure is of little value in controlling cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy. Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.



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



**PENNSYLVANIA WOOD COCKROACHES**

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

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

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

They are seen in late May or June, especially after rains. This roach is often confused with both adult American and oriental roaches. However, the wood roach is chestnut brown and has a dull white band around the edges of the head and back.

Adults are 1 to 1 1/4 inches long. Females have wings covering only about half the body and do not fly. Males have wings longer than the body and are excellent fliers. Females produce about 30 egg capsules, each containing about 32 to 36 eggs. This roach completes one generation per year.

Wood cockroaches are usually found in wood piles, hollow trees or under loose bark. Buildings in wooded areas are prone to have problems with wood roaches during rainy periods. Although this roach prefers to live outside, adult males are attracted to light and may enter buildings. They are sometimes brought in along with firewood, but do not usually survive or multiply inside buildings.

### **Nymphs and Adults**

Nymphs and adults are usually found outdoors beneath loose bark in woodpiles, stumps, and hollow trees. Brought indoors on infested firewood, they wander about the house without congregating in any particular room. They can be especially troublesome during the mating season, which is during May and June. Male wood cockroaches frequently travel in large numbers and fly considerable distances. They are attracted to lights at night and may gain entry indoors. Large numbers may also be found in rain gutters of homes.

Wood cockroaches feed primarily on decaying organic matter. Both female and male wood cockroaches have been found under shingles and on the inside of garages. They rarely breed indoors. However, with the growing use of firewood, the popularity of cedar shake shingles, and the continual building of homes in wooded areas, problems with wood cockroaches will probably escalate.

### **Structural (and Environmental) Modifications and Repairs**

Wood cockroaches are most often carried into homes under the bark of firewood. It is best to not store firewood inside the house. Move woodpiles away from the house to further reduce the likelihood of cockroaches wandering in.

Houses located within woods will sometimes have wood cockroaches crawl under siding; especially homes with cedar shake shingles. To cockroaches, the house may represent a fallen tree and a new location for nesting. A wide lawn will inhibit cockroaches crawling from the surrounding woods to the house. The use of window screening and caulking to prevent entry is a good structural tactic.

### **Control**

The sprays and dusts used with success against household cockroach species are of very limited benefit against wood roaches. Exclusion techniques that prevent wood roach entry should be considered. Doors and windows should be tightfitting and cracks, gaps and other possible entry points should be sealed. If a breeding site can be moved or modified (e.g., relocating a wood pile farther from the house) it might help. Also, store firewood outdoors until you are ready to burn it.

The males are attracted to lights at night and limiting porch light use in late May through June when males are flying might be of some benefit.

Outdoor insecticide barrier treatments around windows and doors and along the foundation or firewood pile are a last resort that may reduce the number of wood roaches that get indoors. Direct application of insecticide to firewood does no good and is discouraged. Wood cockroaches inside need only be picked up discarded.

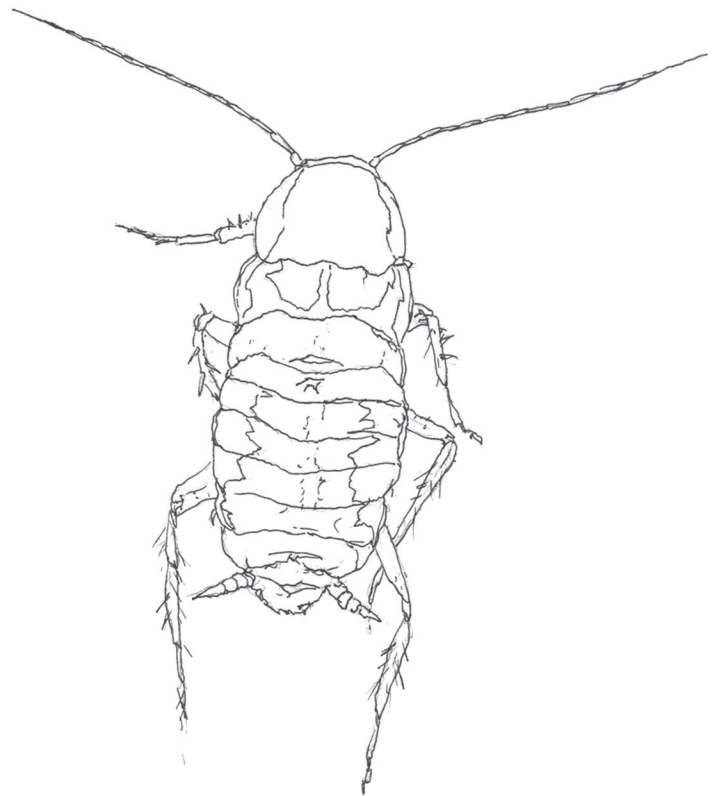
### **Chemical Control**

As breeding populations rarely become established indoors, house interiors should not be treated. Treat exteriors only when wood cockroaches enter homes from the surrounding environment. Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Treat exteriors only when wood cockroaches enter homes from the surrounding environment.

### **Exterior Treatments**

Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair. Changing white incandescent bulbs to yellow bulbs around entrance doors may help.



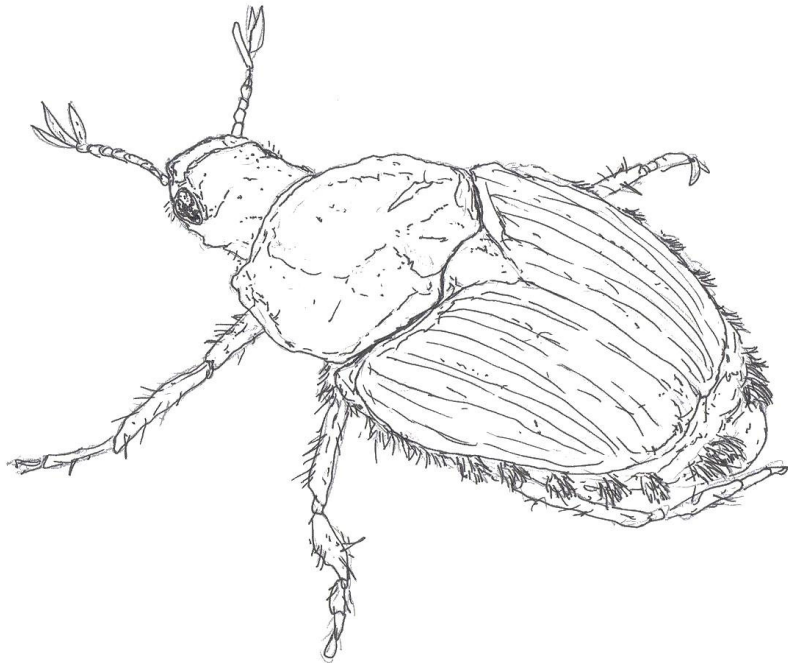
**WOOD COCKROACH**

### **Chemical Control**

Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid.

Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application. The use of residual sprays or aerosol foggers within a structure is of little value in controlling cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy. Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfuramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.

Common names (the names found on the list of active ingredients) of other effective pesticides include: propoxur (Baygon), cyfluthrin, permethrin, deltamethrin, and tetramethrin. A variety of formulations may be available, including sprays (liquid or wettable powders), aerosol sprays, baits or dust. No single chemical or formulation will control all cockroaches. Some German cockroach infestations are resistant to one or more insecticides. Apply insecticides only to cracks, crevices, or unexposed surfaces, and not beyond the point of runoff. Avoid spraying carpets, wallpapers, or other furnishings that might be stained.



**JAPANESE BEETLE**



## Common Cockroach Identification Summaries

In general, peridomestic cockroaches are much larger and heavier than German cockroaches. Adults range in size from 1.5-1.75" (3-4 cm) in length and are reddish brown to black in color. Some of these large cockroaches can live up to 2 years in the adult stage. Adult females can produce an egg case about every 1-2 weeks. A typical female will produce about 20-80 oothecae during her lifetime each containing 15-20 nymphs. Peridomestic females release the egg case from their body soon after it has developed. They then "glue" the egg case to a surface, usually in a hidden, moist area.

In contrast, German cockroach females continue to carry the egg case throughout embryonic development. Peridomestic cockroaches normally breed outdoors in sewers, palm trees, tree holes, fire wood, water meters, well pumps, mulch, and flower beds. These cockroaches usually enter homes only occasionally when foraging for food, water or warmth. In some situations, however, they will establish breeding populations in attics, crawl spaces, wall voids and other indoor areas. Many cockroaches do not live in close association with humans. Others are found in only a few locations. These are considered minor pests.

### American Cockroach

The American cockroach, *Periplaneta americana*, prefers warm and humid environments, usually with temperatures in excess of 82°F. Under the right conditions, they readily live outdoors and are common pests in zoos and animal-rearing facilities. They are also common in sewers, steam tunnels, and masonry storm drains. Occasionally they forage from sewers and other areas into the ground floor of buildings. Adult females carry the egg cases around for about 6 days and then cement them to a protected surface where they incubate for about 2 months or longer. The egg cases, which are about 3/8 inch long, are brown when laid but turn black in 1 to 2 days. Each egg capsule contains about 12 young; a female and her offspring can produce over 800 cockroaches in one year.

### Biology

The length of the egg stage varies from 29 to 58 days. At room temperature, nymphs hatch out in 50 to 55 days. Young nymphs are grayish brown and after the first few molts become reddish brown. The nymphal stage varies in length from 160 to 971 days. The number of offspring per year averages 800. Under ideal conditions an adult female can live up to 15 months, males for a somewhat shorter period.

### Sex

Adult American cockroaches have wings and will occasionally fly. However, they are awkward fliers and prefer to run when disturbed. Male and female American cockroaches are about the same size and look very similar. Both have a pair of cerci, finger-like appendages, at the tips of their abdomens. The cerci are used to detect air movement in the cockroach's surroundings.

Male cockroaches have an additional set of appendages called styli on their abdomens. The styli are located between the cerci but are smaller and more delicate. The presence of styli is the easiest way to distinguish male from female cockroaches. Immature American cockroaches resemble adults, except they are smaller and wingless.

### **Life Stages**

Nymphs (immature stages) resemble the adults, but they are smaller and lack wings. Nymphal early instars (the stage between molts) are grayish brown with a paler lower surface. Older nymphs are uniformly reddish brown. Wing pads are evident in third or fourth instar nymphs. Egg cases (oothecae) are mahogany brown to blackish brown and about 3/8 inch long. The eggs in each egg case are arranged in two parallel rows, usually with 14 to 16 eggs total.

### **Brownbanded Cockroach**

The brownbanded cockroach, *Supella longipalpa*, is not as common as the German cockroach in California and accounts for only about 1% of all indoor infestations. This species seeks out areas that are very warm most of the time, preferring temperatures of about 80°F, about 5° to 10°F warmer than what German cockroaches prefer. Favorite locations include near the warm electrical components of appliances such as radios, televisions, and refrigerators.

Brownbanded cockroaches prefer starchy food (e.g., glue on stamps and envelopes), are often found in offices and other places where paper is stored, and are more common in apartments or homes that are not air conditioned. They also infest animal-rearing facilities, kitchens, and hospitals. Adult males sometimes fly when disturbed, but females do not fly. Females glue light brown egg cases, which are about 1/4 inch long, to ceilings, beneath furniture, or in closets or other dark places where eggs incubate for several weeks before hatching. Each female and her offspring are capable of producing over 600 cockroaches in one year.

### **Field Cockroach**

The field cockroach, *Blattella vaga*, prefers outdoor locations and is usually found in leaf litter and plant debris. Field roaches invade indoor areas when it is hot or dry outdoors and are often mistaken for German cockroaches. Field roaches are more olive in color than German roaches and they have a black stripe between the eyes. Adult females carry the egg cases until they are ready to hatch. Each egg capsule usually contains between 30 and 40 young. Development from a newly emerged nymph to adult can be completed in about 3 months.

### **German Cockroach**

The German cockroach, *Blattella germanica*, is the most common indoor species, especially in multiple-family dwellings. They prefer food preparation areas, kitchens, and bathrooms because they favor warm (70° to 75°F), humid areas that are close to food and water. Severe infestations may spread to other parts of buildings. This species reproduces the fastest of the common pest cockroaches: a single female and her offspring can produce over 30,000 individuals in a year, but many succumb to cannibalism and other population pressures. Egg laying occurs more frequently during warm weather.

The female carries around a light tan egg case (about 1/4 inch long) until 1 to 2 days before it hatches, when she drops it. Sometimes the egg case hatches while it is still being carried by the female. Each egg case contains about 30 young, and a female may produce a new egg case every few weeks.

### **Oriental Cockroach**

The oriental cockroach, *Blatta orientalis*, is sometimes referred to as a water bug or black beetle. It lives in dark, damp places like indoor and outdoor drains, water control boxes, woodpiles, basements, garages, trash cans, and damp areas under houses. It is most likely to occur in single-family dwellings that are surrounded by vegetation. It is also common in ivy, ground cover, and outside locations where people feed pets. Oriental roaches prefer cooler temperatures than the other species do, and populations of this species often build to large numbers in masonry enclosures such as water meter boxes. At night, oriental cockroaches may migrate into buildings in search of food. They usually remain on the ground floor of buildings and move more slowly than the other species.

Oriental cockroaches do not fly and are unable to climb smooth vertical surfaces; consequently, they are commonly found trapped in porcelain sinks or tubs. Females deposit dark red-brown egg cases, which are about 3/8 inch long, in debris or food located in sheltered places. Each female and her offspring can produce nearly 200 cockroaches in one year. Development from a newly emerged nymph to adult can take from 1 to 2 years or more.

### **Smokybrown Cockroach**

The smokybrown cockroach, *Periplaneta fuliginosa*, is usually found in decorative plantings and planter boxes, woodpiles, garages, and water meter boxes; it may occasionally inhabit municipal sewers. They sometimes invade homes, taking refuge in areas such as the attic. Nymphs are dark brown and have white segments at the end of their antennae and across their backs. Smokybrown cockroaches prefer the upper parts of buildings; they also may live under shingles or siding and sometimes get into trees, shrubs, and other vegetation during summer months. Females carry the dark brown to black egg case, which measures about 3/8 inch long, for about 1 day before dropping it; eggs can quickly hatch in 24 days or take 70 days after being laid, depending on temperature. About 40 to 45 nymphs hatch from a single egg case.

### **Smokybrown Cockroach Elimination**

1. Eliminate or alter any conditions which encourage the presence and/or reproduction of the roaches. These pests thrive in dark, humid areas which have little or no air flow.
2. Spray exterior of structure with Suspend SC, Demon WP or Cynoff WP. These odorless insecticides will give a quick knockdown of bugs while lasting for several weeks, usually yielding about 90 day residual. Spray any crack, crevice or entry point on the outside of the structure. This includes treating around all windows, doors, vents and in weep holes of brick veneer.

Also spray tree trunks, from ground to crotch of tree, but no higher than six feet. All mulched areas should be sprayed with your insecticide.

These exterior surfaces should be treated 3 to 4 times each year.

3. If necessary, spray indoors in the following areas: basements, garages, carports, attics, closets, laundry rooms. Also treat beneath and behind large appliances (refrigerators, stoves, etc.) or other areas where these roaches prefer to hide. (Spraying all of your baseboards with any bug spray is not necessary!) Indoor areas should be treated 2 to 3 times per year.

4. Hollow blocks or other areas such as behind brick walls and along plumbing lines should be treated with Delta Dust. Although many dusts will kill roaches, Delta Dust is water-proof and will not be destroyed by the moist habitat of the Smokybrown as would other dusts.

For deeper penetration and better distribution of your insecticide dust, use a Crusader Duster. Delta Dust should be used once each year or as needed.

### **Wood Cockroaches**

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

Adult males are approximately 1 inch long; females grow to about 3/4 inch long. Males are dark brown; the sides of the thorax and the front half of the wings are margined with yellow. Adult males are fully winged, while females have conspicuous wing pads (actually short wings like that of the female oriental roach), which are functionless. Wings of the male are longer than its body, while wing pads of the female cover only one-third to two-thirds of the abdomen. The males fly swiftly but do not have the ability to sustain themselves in the air for long periods.

### **Exterior Treatments**

Exterior treatments to foundations, around doors and windows, porches, patios and other areas where outside lights are located will help control both the adult males (which will fly to the lights) and the females (which crawl to the house in search of harborage). Use only products manufactured and approved for this purpose and carefully follow the instructions on the labels. Do not use chemicals in areas where small children and pets may come in contact with them. Avoid getting spray on sensitive vegetation. For persistent and difficult-to-treat infestations, contact a professional pest-control service.

Control is seldom required indoors because this species usually does not survive inside. Preventative measures is what is usually required. This consists of nailing flashing down tight, sealing exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair, all doors have doorsweeps and self-closing screen doors which are tight fitting and in good repair, and all exterior vents or vent openings are screened with wire hardware cloth no larger than 1/8 inch mesh. Window screening must be kept in good repair. Changing white incandescent bulbs to yellow bulbs around entrance doors may help.

### **Chemical Control**

Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food. Perimeter insecticide sprays may aid in the reduction of cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application. The use of residual sprays or aerosol foggers within a structure is of little value in controlling cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy.

## Topic 2 - Common Cockroach Classifications and Sub-Families Post Quiz Answers in the rear near glossary.

1. The field cockroach, *Blattella vaga* Hebard, is similar to the \_\_\_\_\_ in appearance, but it occurs primarily outdoors where it feeds on decaying plant materials.
2. The \_\_\_\_\_ cockroach, *Supella longipalpa* (Fabricius) is about the same size as the German cockroach, but appear " *banded*" because the wings are marked with a pale brown band at the base and another about a third of the distance from the base.
3. Life Cycle: Mated females produce an egg capsule that is attached to the end of the abdomen for up to a month before being dropped a day or so before eggs hatch. Each 5/16-inch-long, brown egg capsule contains \_\_\_\_\_ (oothecae) which hatch in 2 to 4 days after being deposited.
4. \_\_\_\_\_ hatching from eggs are less than 1/8 inch long and wingless. They develop through 6 to 7 stages (instars) over 74 to 85 days (varying with temperature) before becoming adults.
5. There may be \_\_\_\_\_ generations per year.
6. Some people have \_\_\_\_\_ to cockroaches or cockroach residues (e.g., feces, body extracts).
7. American Cockroach. Adults of this species are 1 1/2 to 2 inches long. They are the \_\_\_\_\_ of all the cockroaches common in the World.
8. Both nymphs and adults are shiny, reddish brown with a pale brown or yellow band around the edge of the head and back. The wings of both the \_\_\_\_\_ extend slightly beyond the body.
9. Wood cockroaches are usually found in \_\_\_\_\_, hollow trees or under loose bark. Buildings in wooded areas are prone to have problems with wood roaches during rainy periods

10. The \_\_\_\_\_ has a great tendency to lose moisture through the cuticle and thus requires water every two to three days.

## Topic 3 - Cockroach Inspection and Treatment Section

**Topic 3- Section Focus:** We will examine the basics of cockroach related inspection, management and pesticide treatments. At the end of this section, you will be able to understand and describe various cockroach inspection techniques, control and elimination applications including fumigation. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

**Topic 3- Scope/Background:** Cockroaches are best controlled through an integrated pest management process of inspection, sanitation, exclusion, and the use of low-toxicity insecticides.



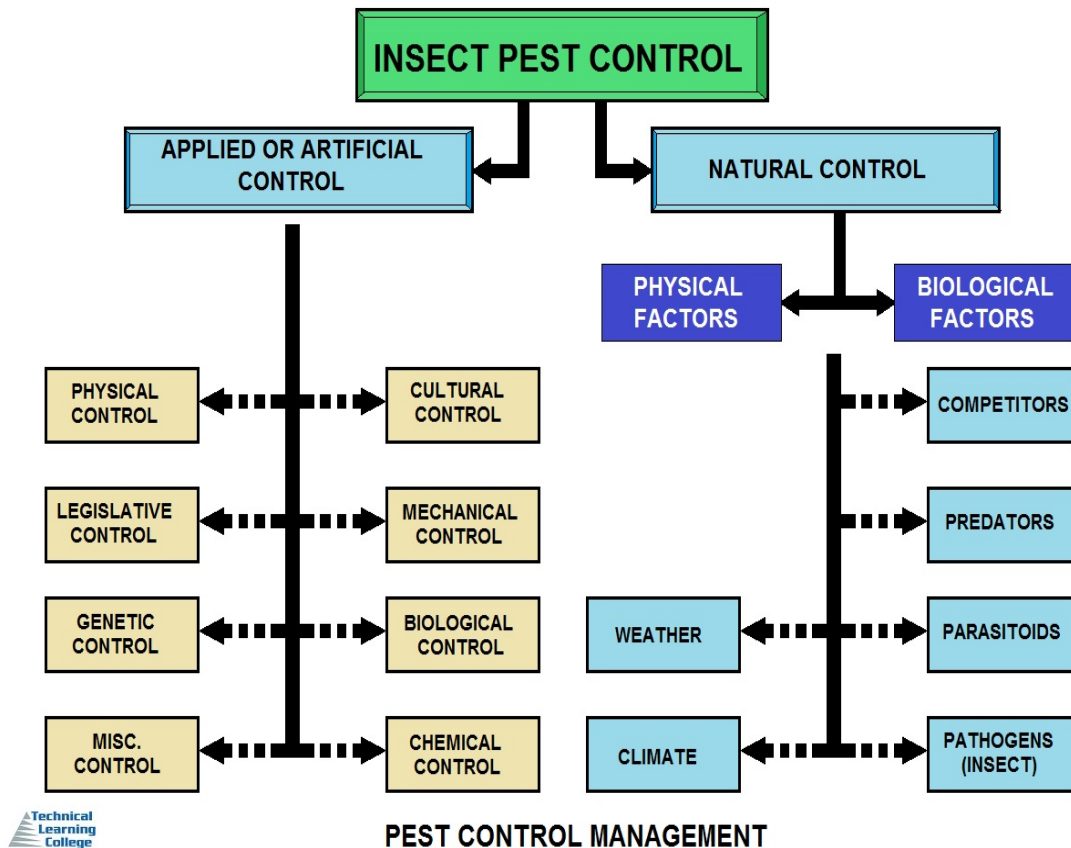
## Cockroach Prevention: Exclusion and Sanitation

### Principles of Effective Cockroach Control

Before we examine the inspection section, we believe the first step in cockroach control is to keep the insects out of the home or business. Because roaches do not generally survive winter conditions (except for wood roaches), you need not worry about them entering homes directly from outside. Unless you live a warm winter area. However, roaches may be transported into homes on items coming from elsewhere. Old used items are especially likely to carry the pests.

Once a home or business is infested, the object is to deprive roaches of food, warmth, moisture and undisturbed dark cracks and crevices. Keep dishes washed, food in tight containers, garbage in tightly covered cans, dry pet food out of their reach, cracks caulked and gaps around pipes filled with steel wool, caulk, or other sealants.

## Integrated Pest Management (IPM) Approach

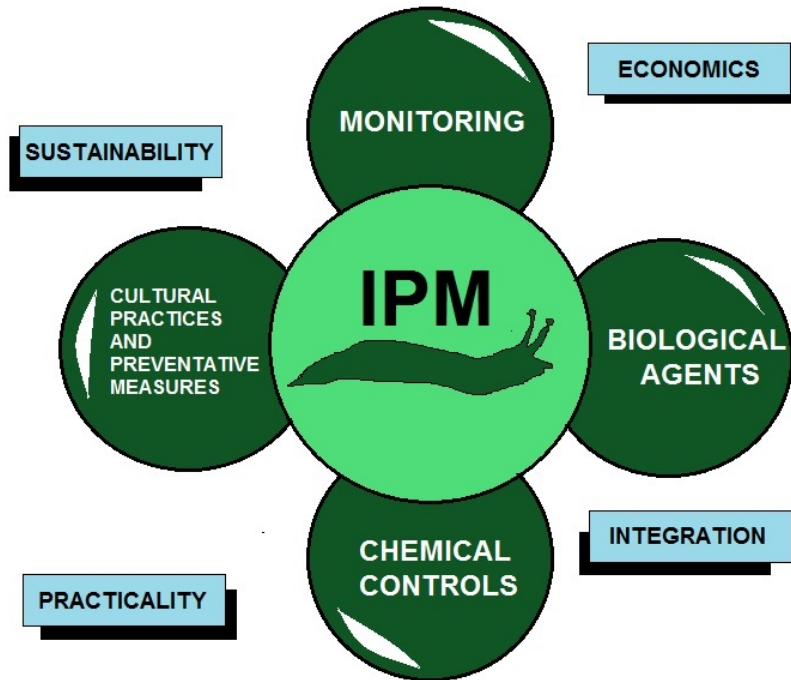


The key to effectively eliminating cockroaches is to follow an Integrated Pest Management (IPM) approach. It includes the following steps:

- An inspection to find where and how serious the infestation is;
- Identification of contributing factors (such as sanitation problems), and taking corrective measures;
- Use of various tools to kill cockroaches and continued monitoring and treatment as needed.

All of these procedures are essential to maintain a cockroach-free living environment. Long term prevention of cockroach infestation is the best means of ensuring a cockroach free environment. This is most easily accomplished by means of exclusion (preventing cockroach entry) and sanitation (elimination of cockroach resources). Not only will these measures prevent a future infestation, they will also help to reduce an existing cockroach problem.





## INTEGRATED PEST MANAGEMENT (IPM)

### Exclusion - Preventing Cockroach Entry Locations

1. Children can transport cockroaches from school to home in book bags and lunch pails. Inspect these items on a regular basis.
2. Cockroaches migrate easily through multi-unit dwellings via plumbing and electrical connections. Sealing gaps around plumbing, wall outlets and switch plates will prevent cockroaches from migrating from infested units to others.
3. Fiberglass window screen over vent pipes on the roof will prevent cockroaches from migrating up from sewer connections and gaining access to attics and windows.
4. Groceries, produce and other packaged food products may have been stored in infested locations before they were purchased. Make an effort to visibly scan all grocery items for cockroach evidence before putting them away.
5. Guests (adults and children) can often transport cockroaches from their infested home to yours either on themselves or in packages. Limit guest access to specific areas of your home and inspect these areas after they depart.
6. Keep doors and windows closed and screened. Also, caulk cracks and gaps that may allow peridomestic cockroaches to invade from outdoors.
7. Peridomestic (Living in and around human habitations) cockroaches frequently enter homes by coming up through dry drain traps. Periodically run the water in spare bathrooms, utility tubs and toilets to keep the drain trap filled and off limits to cockroaches.

### Sanitation Elimination of Food Resources

German cockroaches can remain alive for approximately 2 weeks with no food or water and for 42 days if only water is available. While that time, these creatures are laying eggs for the next generation. Therefore, it is important to realize that cockroaches can survive on tiny amounts of food such as crumbs, grease or food residue.

### **Customers' Needs List**

It is a difficult concern when customers are responsible for unsanitary conditions in which cockroaches thrive. Most of us will see about 70 percent of our treatments are in businesses or homes that are unsanitary. I often make a record of restaurants that I will not eat at after I've performed a cockroach inspection. There are days that I am unable to find a food related business that I can comfortably eat at. I believe that you as a pesticide professional will do a better job of inspection than most health inspectors and you too will have trouble finding a safe and clean restaurant. Maybe this is possible in a cold climate. I remember inspecting a Chinese fortune cookie making operation, because of the cockroach infestation, I can never eat fortune cookies again.

### **Ideal Customer's Sanitation List**

*It is difficult to tell the customer these concerns and most of us do not have the time.*

1. All foods products should be resealed after opening, stored in plastic snap-lid containers or kept in the refrigerator.
2. Feed pets at particular times and clean up after every meal. If pets are present, dry food should be kept in re-sealable containers. Do not leave food and water out all the time.
3. Filled indoor garbage containers should be removed from the dwelling immediately and placed in outdoor containers with tight fitting lids or dumpsters.
4. Frequent emptying of sink strainers and running of the garbage disposal and will prevent food build up in the sink drain.
5. Indoor trash containers should be emptied frequently, kept clean both inside and out. Plastic bags lining trash containers can be kept closed with twist ties. This will prevent cockroaches from being attracted to the garbage area. Keeping the area around dumpsters or other outdoor garbage storage areas clean and free of debris will also prevent peridomestic cockroach infestations in the area.
6. Kitchen appliances (toasters, toaster ovens, microwaves, ovens, stoves, and refrigerators) should be kept clean and free of food particles and grease. Additionally, the areas underneath and behind these appliances should be kept grease and crumb free.
7. Regular cleaning of food storage areas and shelves not only eliminates spilled or scattered food but disrupts cockroach populations that may be using the area as a harborage.
8. Regular sweeping/vacuuming of floors and furniture where people eat (i.e. kitchen table or in the living room in front of T.V.) help to eliminate cockroach food sources.
9. Washing dishes immediately after a meal will prevent cockroaches from consuming food residue on dishes. Unwashed dishes are a major source of food for German cockroaches.

### **Elimination of Moisture Resources**

The single most important factor in determining cockroach survival is availability of water. Again, German cockroaches live less than two weeks when there is no supply of free water even if food is abundant. During periods of drought the incidence of peridomestic (Living in and around human habitations) cockroaches indoors will often increase as the large cockroaches invade structures in search of moisture. It is therefore important to eliminate all sources of moisture that contribute to cockroach survival.

Most of this information seems repetitive, however, we need to figure out ever source to an infestation and most of the time, the customers are to blame either knowingly or unknowingly and it is difficult to tell them these concerns.

So, we will master this area and learn to be wise as a serpent and gentle as a dove when describing these concerns during your inspection and price quotes. It is similar to telling a stranger that they have bad breath and it is their fault and trying to be their friend.

### **Common Moisture Resources**

1. Refrigerator: A common source of moisture is condensation under the refrigerator. This area should be frequently wiped dry or, if possible, a pan should be placed under the appliance to collect water. The collection pan should be emptied frequently. Condensation on pipes (under the sink or in wall voids) is also a problem. Insulate these pipes if possible. Or a leaky waterline to the ice maker. This type of leak is generally difficult to find but is a fountain of life to cockroaches.
2. Indoor plants: Be careful not to over-water indoor plants, because excess water is available to cockroaches.
3. Dishware: Glasses, cups and soda cans containing water or liquid residue are common sources of moisture for cockroaches. Be sure not to leave these containers in bedrooms, sinks, on counter tops or other areas. Rinse and invert cups and glasses to dry immediately after use and dispose of soda cans in trash containers.
4. Pet Feeding: Pet drink dishes and aquariums are also sources of moisture. Empty pet water dishes at night when cockroaches are foraging but the pet is indoors or asleep. Aquariums should have tight fitting lids or screens to prevent cockroach entry.
5. Water: Steps should be taken to eliminate places where water collects outdoors (tires, cans, tree holes etc.). This will not only eliminate cockroach moisture sources but also mosquito breeding habitat.
6. Leaks: Tightening loose pipes, patch plumbing leaks and replace used washers in the kitchen sink and bathroom areas. Outdoor water spigots and sprinklers should also be checked for drips and leaks.
7. Sinks: Water left in the sink or bathtub after dish washing or bathing also provides moisture for cockroaches. These sources are eliminated by drying out sinks and bathtubs after use.

### **Elimination of Harborage Resources**

Cockroaches hide in dark narrow cracks and crevices. They tend to gather in corners (in the back of cabinets or drawers, for example) and generally travel along edges such as baseboards. Again, they are most active during the night. The third critical element for cockroach survival is harborage or shelter or clutter. By nature, cockroaches avoid open, well lit areas with frequent air movement. They prefer dark, warm cracks and crevices. Excess clutter provides numerous locations suitable for cockroach habitation. Cockroaches eat many kinds of materials. They are especially fond of starches, sweets, beer, and meat products. They also feed on leather, bakery products, flakes of dried skin, dead animals, and plant materials.

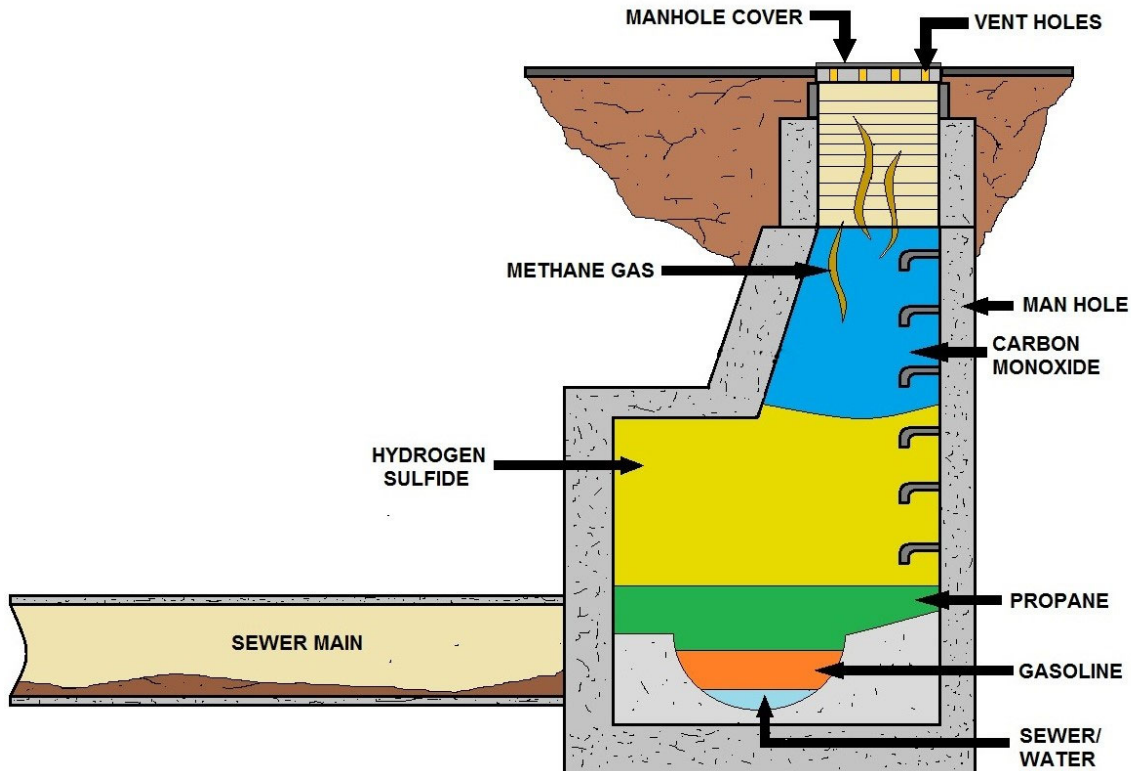
The elimination of these harborages (clutter) is important in controlling infestations. Again, it is difficult to inform the customer of these following concerns, however, many customers will pay you to remedy these concerns. Some applicators do not care or others think these concerns are not essential and that these concerns are basically job security. I have seen many different approaches on these issues. I am at the point of my career to say that, if you are able and have the time, always do the best job you are able to do and consider that you may never return to this customer in the future, but you want to leave a good impression.



## Cockroach Access Control Measures

1. Adult cockroaches can fit into cracks only 1.6 mm wide (about 1/16 of an inch). Any small gap or hole that leads to a void is a prime cockroach harboring area. Cracks and crevices of this kind should be sealed with a tube of caulking.
2. Filling in tree holes with cement also eliminates peridomestic cockroach harborage.
3. Keep palm trees free of loose and dead palm branches and remove all palm debris.
4. Keep shrubbery and ornamentals well-trimmed.
5. Outside, remove debris and trash from around the house.
6. Removing clutter (boxes, bags, clothing, toys, food, books, papers etc.) eliminates cockroach harborages and breeding areas. It is essential to keep all areas of the home, especially the kitchen and bathroom, uncluttered and free of useless debris.
7. Stack firewood far away from the house, as this is a prime harborage area for peridomestic cockroaches.

## Cockroach Inspection - Introduction



**POSSIBLE HAZARDOUS ATMOSPHERES PRESENT IN A CONFINED SPACE  
(EXAMPLE IS OF A SEWER MAIN)**

*Cockroaches thrive inside confined spaces like the manhole in the above diagram. Always be careful of dangerous gases and /or lack of oxygen while working inside manholes.*

### Inspection Equipment

Proper equipment is essential for conducting a cockroach inspection. For inspecting a customer's business, home or apartment, the following five items are recommended:

1. A flashlight to illuminate dark areas where cockroaches like to hide. To be able to find and identify feces or cockroach habitation, like feeding areas.
2. A mirror with extension arm (such as a dentist's) to help see hidden areas, like behind sinks, under refrigerators and appliances. Some applicators have video monitoring equipment that attaches to the smart phone. These devices help identify problem pest areas to the customer and are great sales tools.
3. Monitoring traps. We recommend a minimum of six traps but prefer ten traps. We will describe later.
4. A probing, tapping or crevice tool, like a screwdriver, a tool that can probe, tap or open cockroach areas. There are professional probing type tools available.
5. A digital camera. Today's customer's may ask for a digital record of your efforts and these photographs will generally prove your work and keep the customer happy.

### **The Inspection - Visual Examination**

The inspection principles will be similar for rodent inspection and will work for German, brown-banded, oriental and American cockroaches. It will be helpful to get answers from the customer for the following questions.

- Where did you first see cockroaches?
- Where do you see them now?
- Normally, the customer will explain more clues about the infestation and you will need to examine the clues, like wet areas, access to food, etc.

### **Past Efforts**

If you are there for the first time, consider past or present professional pest control efforts. If the previous pest control tactics included the use of insecticides with a strong repellent effect (this includes most of those currently used today), the cockroach infestation may have moved from its original location. In this case, you should spend some time exploring locations where insecticides were not used, like false ceilings, behind walls and other areas above your head. I once found a huge infestation behind a toilet tank.

### **Map the Area**

While performing a detailed examination of the area, take an overall look at the premises, inside and outside. Build a picture of traffic patterns for people. Customers will not understand that you are building this map inside your mind. This operation is similar to inspecting for rodents, termites or bedbugs.

- In particular, where is food brought in?
- Where is it prepared? Where is it eaten?
- How are leftovers and other garbage disposed of?
- Is the trash emptied in a timely manner?

Perhaps the cockroaches hitchhiked into the kitchen with food supplies. Consider food storage and related activities, such as recycling bins and cardboard boxes.

- Could these be encouraging the problem?

If introduction with food is confirmed, try to identify where the cockroaches originally came from.

- Could cockroaches have been brought into the residence by someone who works in infested buildings?
- Are there college kids who frequently move between apartments and home?
- What about sewer drains, roof drains, improper plumbing connections?
- What about grease traps and trash removal?

Cockroaches may be lazy however they are smart and move into residences and businesses from other infested buildings. In apartments, the cockroaches may have first entered from outside or from adjoining units. You should check possible entry points such as around water and drain pipes under the sinks, sewer pipes, steam supply pipes, conduits for electricity or crevices in walls connecting with other infested areas. Identifying the origin of the cockroaches is valuable from the long-term viewpoint to prevent re-infestation.

There are several concerns that you as the inspector need to think about. You will quickly learn how to deal with these concerns. The problem is time. Most applicators are pushed in time.

We are taught to do the job quicker than we are supposed to do. Some of us have to do a poor job unless we have to sell or push a treatment or chemical. In essence, it will take about one year to figure out the basics of cockroach inspection and control, but you will never completely master it with today's treatments.

### **Dark Locations – Similar to Rodents**

Cockroaches are similar to mice and like warm, dark locations near food and water. It is helpful to note all those factors favoring cockroach survival once they have gotten into your home. Since cockroaches need food, look for food sources, such as fresh fruits or vegetables and pet foods. Also, look for food spills or buildup of food material in or under counter tops, stoves and refrigerators. Look in mops and brooms, inside the rims of the floor drain, around the wheels of mobile carts and other similar places. You should also check less obvious food sources, like rodent bait stations, for signs of cockroach activity. Cockroaches aren't killed by rodent baits.

Cockroaches need water as well as food, so check for condensation or leaks providing a water source. Don't forget to consider less obvious sources of water such as planters, pet water dishes and fish tanks.

In addition to food and water, cockroaches need daytime hiding places in which to rest and breed, and these harborages must be identified during the inspection. Once again, use your knowledge of the target pest to focus your efforts. German cockroaches prefer dark crevices close to moisture.

Cockroaches prefer bare wooden surfaces, cardboard or paper because these surfaces are easier to climb and because porous surfaces retain their aggregation pheromone. They will also be found in stacks of paper, grocery bags, letters and other paper items.

Pay particular attention to fixtures made of wood, such as storage shelves, wooden tables and cabinets. Also check behind and under appliances, in the corners of rooms at floor or ceiling level, behind pictures and around the legs or wheels of carts as well as in appliance voids.

Don't forget to inspect suspended ceilings. Sometimes cockroaches become trapped in such things as spider webs, light fittings and partially empty beverage bottles.

Look for every clue you can when identifying the problems. In general, the harder it is to gain access to a potential harborage, the more likely it is to be infested. The simplest method to monitor cockroaches is to visually inspect cockroach hiding places using a flashlight and then place a glue trap.

Places such as behind the refrigerator, under the sink, crevices in cabinets and shelves, closet door corners, and bathroom cabinets and closets are especially important. If you are still not sure about the cockroach infestations after a visual inspection, you can use the following monitoring tools.

### **Placing Traps - Known Infestation Areas**

In addition to putting traps in known infestation areas, you must also place enough traps to “cover” the areas of suspected infestation (with German cockroaches this means the kitchen and bathrooms).

To accomplish this, first put at least one trap in each of the following locations:

- 1) beside or behind the toilet,
- 2) under the sink in the bathroom,
- 3) beside the shower or bathtub,
- 4) under the kitchen sink,
- 5) behind, under or beside the refrigerator,
- 6) beside, under or behind the stove,
- 7) in the back of each kitchen cabinet,
- 8) beside or under the water heater (if available),
- 9) behind or beside the washing machine,
- 10) behind or beside the automatic dishwasher.



## Cockroach Control Procedures for a Restaurant Kitchen



Start with a thorough inspection, it is best if the kitchen staff was to do a thorough cleaning the night before the inspection. It is also great if you can be there a couple of hour before the food preparation begins. Always wear gloves during your inspection and treatment. Most technicians do a poor job when dealing with cockroaches, generally because of time limitations. This procedure may work for complete cockroach control for as long as you maintain treatments. This procedure is not a money maker on the first three treatments but you will make money down the road and have a satisfied customer for life and the word of mouth advertising is the best form of advertising.





Set-up your roach traps for monitoring behavior, you can cut these tents in half or use one large trap. It is best to place these devices these everywhere, including in the ceiling. These traps will tell you volumes of data about our pests, tents are great control and monitoring tools. A lot of these procedures are suggestions and the best rule is to follow the pesticide or device directions. Once in a while, I will add a dab of roach killing gel or bait to the trap or tent. The first treatment after inspection and proper pest identification is to apply the roach hormone growth regulator and dust all the cracks and crevices with boric acid or equivalent chemical and use a flushing spray. Return back in one week with the following tools (see *below*). Now it is time to lay down the hammer and smash the roaches. You don't have to use the same pesticide products as I do; there are many good and comparable pest controlling products. I prefer these products below and they are readily available in my area.





After the first treatment, return again in 7-10 days and give the roaches the chemical treatment. Return with different chemical treatments every three to six months. On the top, I am using Maxforce Magnum Roach Killer Bait Gel for it works very well. In simple terms, cockroaches love grease, they prefer a dirty kitchen, they will thrive on the back of cooking areas and eat the grease forever but if the kitchen is professionally cleaned, the roaches will eat the bait gel. Cockroaches are just like humans and they prefer a hot T-bone steak over a cold piece of pizza and that is how they look at killer bait gels. Cockroaches love electrical boxes and electrical equipment, there are many reasons; the areas are warm and have a vibration similar to their natural homes. Just apply a thin dap of killer bait gel to all electrical boxes and vents. FYI, I have found the same of bedbugs. I also dust with boric acid to add a little extra killing power for those hard to reach roaches.





Sometimes you have to hammer roaches with a spray. I like CB-80 Extra for two reasons, one is a great flushing agent and two it leaves little or no residual. One telltale sign of cockroaches is their musky smell, pull out a refrigerator and smell around the compressor, you should smell the roaches if they are there. It takes a few years but you will recognize the odor of roaches, the most common is German Browns, they are easy to kill, they are not like scorpions or bed bugs. The only effective method of cockroach control is keeping your kitchen super clean and very few people do that, which is one reason why we have job security and roaches will never die.





Bookkeeping is super important for both the customer and for you. I like to make a customer log book and leave it at the restaurant with my procedures and my findings. The health inspectors love to see these log books and the customer likes to be able to prove that they are trying to fight these pests. I always write that "Kitchen needs to be cleaned and the sides, backs and the bottoms of equipment need to be cleaned on a daily basis. These log books are excellent methods of keeping your customer for a longtime. Customers actually like that you will document your treatments and successes. I want the roaches to eat the killer bait and not the grease. Also spray the outside and entry ways with your B and G and/or Backpack sprayer.



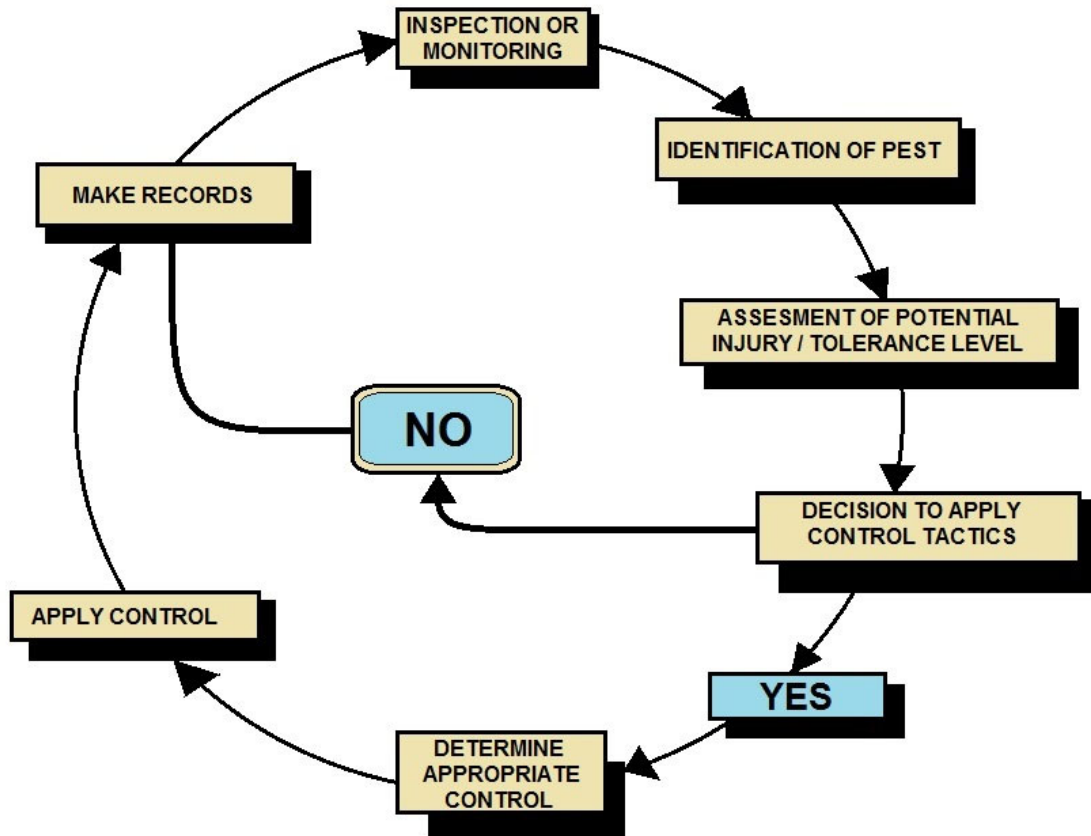


Return every 7-10 days and inspect traps. There are many different traps; I like both pheromone and plain type of traps. One method roaches and rats get in to the building is through drop-ceilings. You will need to treat the inside of a drop-ceiling with a heavy treatment the first couple of times if roaches are returning.

Roaches love strip malls and shell buildings, so be aware of their advanced minds and outsmart them. Roaches also love to eat at grease traps and outdoor grease storage areas. I have seen many customers that were very happy that my treatment plans worked and they always tell others about my service. The big pesticide chains will not do this detailed service, but will send a "return or call back" out to take care of the problem.

Spend the extra hour and hammer the roaches on your first two and six month treatments, the other additional treatments will only take a few minutes. I calculated my costs for a roach infested kitchen, in the first two visits, it cost me approximately \$60 in chemical and traps and \$100 in time and mileage. I made \$75 and while losing \$85. But I gained 14 more accounts and now I return each week and make \$35 profit per treatment. I think this is called a "lost leader" in the grocery market business but I have 15 more customers for the rest of their lives.

## IPM Methods for Cockroaches (*Types of Pest Control*)



## INTEGRATED PEST MANAGEMENT (IPM)

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

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

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

**The four steps include:**

**Set Action Thresholds**

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

**Monitor and Identify Pests**

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

**Prevention**

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

**Control**

Once monitoring, identification, and action thresholds indicate that pest control is required, and preventive methods are no longer effective or available, IPM programs then evaluate the proper control method both for effectiveness and risk.

Effective, less risky pest controls are chosen first, including highly targeted chemicals, such as pheromones to disrupt pest mating, or mechanical control, such as trapping or weeding. If further monitoring, identifications and action thresholds indicate that less risky controls are not working, then additional pest control methods would be employed, such as targeted spraying of pesticides. Broadcast spraying of non-specific pesticides is a last resort.



## Six Basic Components

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

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

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

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

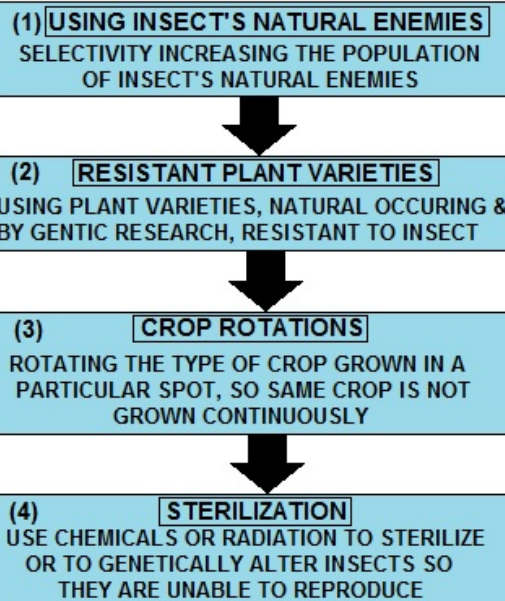
**4. Mechanical controls:** Should a pest reach an unacceptable level, mechanical methods are the first options to consider. They include simple hand-picking, erecting insect barriers, using traps, vacuuming, and tillage to disrupt breeding.

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

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

# BIOLOGICAL CONTROL METHODS

## FOUR AREAS OF BIOLOGICAL PEST CONTROL



### Main Focus of IPM Programs

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

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

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

### 1. Proper identification of pest - What is it?

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

## **2. Learn pest and host life cycle and biology.**

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

## **3. Monitor or sample environment for pest population - How many are here?**

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

## **4. Establish action threshold (economic, health or aesthetic) - How many are too many?**

In some cases, a certain number of pests can be tolerated. Soybeans are quite tolerant of defoliation, so if there are a few caterpillars in the field and their population is not increasing dramatically, there is not necessarily any action necessary. Conversely, there is a point at which action must be taken to control cost. For the farmer, that point is the one at which the cost of damage by the pest is more than the cost of control. This is an economic threshold.

Tolerance of pests varies also by whether or not they are a health hazard (low tolerance) or merely a cosmetic damage (high tolerance in a non-commercial situation).

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

## **5. Choose an appropriate combination of management tactics**

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

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

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



**Inside a large sewer main looking for cockroaches.**

#### **6. Evaluate results - How did it work?**

Evaluation is often one of the most important steps. This is the process to review an IPM program and the results it generated. Asking the following questions is useful: Did actions have the desired effect? Was the pest prevented or managed to farmer satisfaction? Was the method itself satisfactory? Were there any unintended side effects? What can be done in the future for this pest situation? Understanding the effectiveness of the IPM program allows the site manager to make modifications to the IPM plan prior to pests reaching the action threshold and requiring action again.

## Summary

### Prevention

Entry and establishment of roach colonies can be prevented by close inspection of incoming merchandise, such as food boxes, beverage cartons, appliances, furniture and clothing.

Caulking or puttying areas such as cracks and crevices around kitchen cabinets, bathtubs, water and plumbing pipes, cracks on floors and walls, and exterior windows and doors can eliminate most hiding places and help reduce the cockroach population. Other structural modifications, such as weather stripping and pipe collars, also help to reduce cockroach entry and establishment.

### Sanitation

Good housekeeping is the most important factor in preventing and controlling cockroach populations. Cockroaches cannot live without food, water and shelter. Do not allow food particles to remain on shelves or floors.

Dishes should not be left unwashed after a meal, particularly overnight. Clean areas under refrigerators, stoves, sinks and furniture regularly to remove bits of food that have accumulated. If pets are fed indoors, do not leave food in their dishes after feeding, especially overnight. Store pet food in tight containers, and clean litter boxes frequently.

Keep all food items covered or in a refrigerator at all times between uses. Empty garbage and waste containers frequently and keep refuse in a covered container away from the residence.

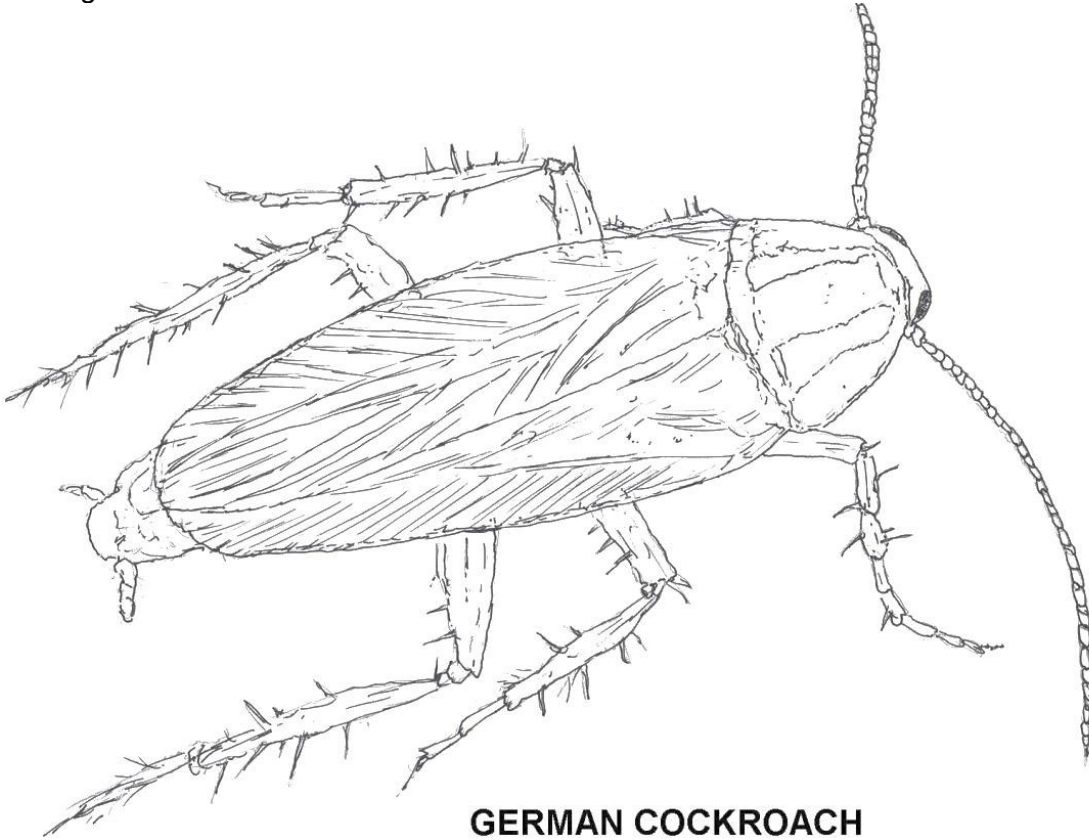
If possible, prevent cockroach access to water sources. Common sources include leaking faucets and pipes, drains, toilet tanks, wash basins and sink traps, aquaria and water-filled tubs. Pets' water dishes, beverage bottles or cartons, and pipe condensation can provide an adequate water supply for roaches. Roach breeding is encouraged by clutter. Avoid unnecessary storage of corrugated paper boxes, piles of paper bags, newspaper, magazines, and soiled clothing and rags.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded.

No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.



**GERMAN COCKROACH**

## Pesticide Applicator Observations

The following are some of my following little observations that I've noticed during my years of teaching. I do not endorse any of the pesticide products.

Right photograph, here is a hand compress spray applicator. Known in the industry as a B&G sprayer. This sprayer will apply most liquid products. A necessary tool for any applicator. Many applicators will have several backpacks with various chemical treatments.

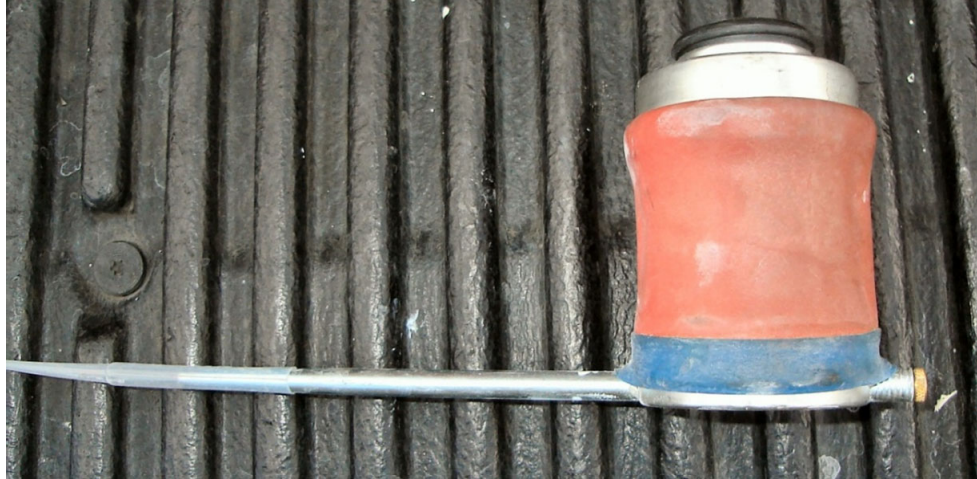


Top photograph, old fashion hose reel spray set-up.

Most applicators have gone to a backpack style product applicator; this is your primary moneymaking tool if properly utilized. I said “product” and not “chemical” or “pesticide”. For some reason, customers prefer the word “product” or “treatment” especially when you are applying pesticides. Here is my commentary, for some unknown reason, a majority of the younger applicators are doing a horrible job at applying product and conducting customer service. The larger firms are going through several new hires and only keeping a few of their trainees. This process is costing companies thousands of dollars and losing customers and I can't figure it out. One suggestion, this type of job requires lots of professionalism and customer service and when we run from one job to another, we start losing focus and soon “burn out”.

The item on the right is often referred to as a “Centrobulb” or duster. This is a brand name and many variations are found. It is a simple tool to apply powder, dust or granular baits. An insecticide duster delivers a fine application of your favorite insecticidal dust. Get one that is non-conductive to electrical lines and switches. I have noticed that applicators will utilize this tool and proper product in areas that are wet or receive rain. This is a good use of product and good idea.





The above photograph is a Crusader Duster or dust applicator and is great for voids in walls or cracks and crevices. Just pour your product in the top and squeeze the product into the cracks or inside switch plates. You've got to get in the pest's home to kill them! Notice the plastic tip so that you don't get an electric shock. This moneymaking tool is great to kill cockroaches, bees or termites. I've heard enough complaints from applicators that they are unable to kill certain pests. Cockroaches are one of the easiest to kill if you can get product on them.

Right photograph, I like to call this my coffee pot type of dispenser. It is a hand held compressed air spot applicator for indoor use. I like to use Phantom or equivalent products in it and it works like dynamite on ants and termites alike. Notice the two red backpacks on this truck. Always have a backup backpack. Always follow the pesticide label's instructions and not my comments or suggestions. Some of my suggestions may be illegal in some areas or for certain products. Always follow the label!



Bottom photograph, Drax Gel (i.e. - Orthoboric acid 5%): Indoor ant bait in gel form. The "double barrel" syringe delivers both sugar and protein baits in one easy application. Bait can be placed in small amounts to cracks, crevices and other areas where conventional bait stations cannot be used. We have found excellent control of household ants by combining Drax Gel with FluorGuard bait stations. This ant bait combo gives you quick control of indoor ant populations. You will often find ants inside areas that have cockroach infestations.







Utilizing the same application gun, is an example of an ant bait which is the ideal means of targeted elimination of ant infestations. Baits are used to kill the entire colony, not just foraging workers. If the ants bite such as fire ants or if they are carpenter ants this is the product you need. The granules are unobtrusive, ready-to-use, and take less time to apply than conventional insecticides.

### Termidor

Termidor is applied at very low rates. Typically, the active ingredient (fipronil) is just 0.06% of the solution, a concentration much lower than that of older liquids and less than most insecticides. For an average home treatment, only about 8 ounces of the active ingredient is actually used. Keep in mind, too, that since 1995, fipronil has been used around the world for flea and tick control on household pets and on agricultural crops to protect food supplies. Termidor has virtually no odor, which means you and your family won't notice a thing. Termidor is made from a revolutionary new non-repellent or "undetected" chemical technology treatment. That means termites cannot see, smell, taste or avoid Termidor. Instead they contact, ingest, and share it with their nestmates. This is in sharp contrast to older liquid termite controls, which rely on repellent barriers that termites can find breaks in or avoid completely. Mix this in your backpack and never mix with a contact killer. Always have a backup backpack. Always follow the pesticide label's instructions and not my comments or suggestions. Some of my suggestions may be illegal in some areas.





Cockroaches have been here since Adam and Eve and at one time larger in size than today's little size. As an applicator, you will see things that will set you right. Because of your route, you may never eat again at a certain restaurant. I've seen such large infestations in homes and restaurants. But this product has shown success in killing those little creatures. Place Avert cockroach bait into cracks and crevices; holes; pipe chases; undersides of furniture; under drain plates; in or under trash containers; hidden surfaces around sinks and storage areas; behind baseboards; around doors and windows; inside, behind and under cabinets, drawers and shelving; under and behind appliances such as stoves and refrigerators; and in attics and crawl spaces. Also apply in points between different elements of construction, between equipment and floors, openings leading to voids and hollow spaces in walls, equipment legs and bases and crawl spaces where roaches hide. During follow-up applications, inspect bait placements and re-apply when necessary. Care should be taken to avoid depositing cockroach bait onto exposed surfaces. If gel contacts an exposed surface, remove gel and wash exposed surface. This product may also be used in food/ feed areas of food/ feed handling establishments. Believe it or not, this little tube is good for several applications. Let's get it right and make some money and keep those customers.

Roach baits are formulations that are attractive to roaches and (when eaten by the insect) are lethal to roaches. There are different types of baits that can be used, depending on roach species and area to be baited. The basic baits covered in this article are bait stations, bait gels and granular baits. Roach bait stations can be used indoors or outdoors; indoor use is usually recommended. Roach bait gels can be used indoors and can also be used on the exterior surfaces of buildings. Granular baits are usually used outdoors (in mulched areas where larger roaches breed or hide) but can also be used in attics or wall voids.

For best results, do not combine contact insecticides with baits. (A contact insecticide is a granule, liquid spray or aerosol that is used to directly kill targeted pests.)

Two bad things may happen when you use a contact insecticide in the same area where baiting programs are implemented: your bait is contaminated and any domino effect will be neutralized. If you contaminate your roach bait with another insecticide, the bait will no longer be attractive to the targeted roach population. If you kill a roach with an insecticide spray, it will die before it passes the bait on to the rest of the roach population, thus killing your domino effect. The same is true when baiting for ants. You want the foraging worker ants to carry your bait back to the nest where all ants will consume the bait.

Many people are concerned when they see the amount of active ingredients in an insect bait. These people think that they are not getting their money's worth because the amount of active ingredients (insecticide or killing agent) seems to be very low. When baiting roaches, ants, silverfish or crickets, you do not want to see large amounts of active ingredients in the formulation. If insecticide levels are too high (in an insect bait), the targeted pest will be repelled instead of being attracted to the bait. The low amount of active ingredients in a roach bait (or other insect baits) is an attractive property to many people who wish to use as little insecticides as possible.

While I am on the subject, here is a super insect growth regulator. An insect growth regulator is by definition a juvenile hormone mimic, a material that inhibits the growth or maturity of certain insect pests. An insect growth regulator (IGR) is an important pest management tool because it helps to reduce, eliminate or prevent infestations of targeted pests without the use of conventional contact insecticides, thus reducing or eliminating the need for pesticides in homes, hospitals, restaurants, warehouse or any area where certain pests are not welcome.



Hydroprene is an IGR that was first introduced to the pest control industry under the brand name Gencor IGR. Gencor was used to help prevent or control populations of indoor roaches, most commonly used against German cockroaches. Always have a backup backpack. Always follow the pesticide label's instructions and not my comments or suggestions. Some of my suggestions may be illegal in some areas.

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

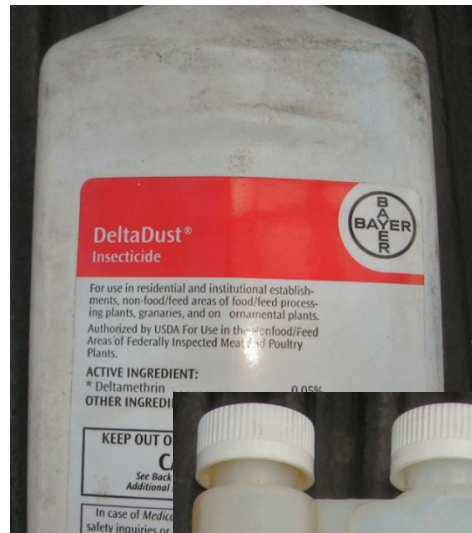
This particular beetle is affected by Methoprene, another IGR that is widely used in indoor flea control programs. The Methoprene products used by professional pest control operators are sold under the brand name of Precor.

When cockroaches are exposed to Gentrol (any form or type) people usually report seeing crippled, deformed or otherwise odd looking roaches. These deformities are to be expected. Young roaches (also called cockroach nymphs) have an exoskeleton or outer shell. (Mammals have an internal skeleton or bone structure.) As roaches in their nymphal stage grow, their exoskeleton or outer shell becomes too small to contain the insect. As they reach the limits of their exoskeleton a new, flexible exoskeleton forms beneath the old one and the old "shell" splits open to allow the nymphs to molt. This transition denotes what is called a different instar or stage of development.

## Delta Dust

Delta Dust (i.e. Deltamethrin .05%) I am not here to endorse this product, but I have found great success inside wall voids. It will kill cockroaches and ants and that is good enough for me. This odorless, non-staining product is the world's only water-proof insecticide dust!

Besides indoor and outdoor applications, it can also be used on ornamental plants. When left undisturbed, Delta Dust kills crawling insects up to eight months. Because it is water-proof, this insecticide dust will not absorb moisture (which destroys other dusts) and it will not clump. Provides quick control of ants, bees (especially carpenter bees), cockroaches, fleas, silverfish, ticks, and numerous stored product pests. Also an invaluable tool for controlling Boxelder Bugs, Ladybugs, White Footed Ants and Pavement Ants. Deltamethrin is a synthetic pyrethroid insecticide.



We do not endorse any product but ExciteR is one of my cricket killers of all time. Once you spray this product, you'll see every type of critter run for its life. This is a 6% concentrate of liquid pyrethrin used for fogging and spraying.

Using 1 to 4 ounces per gallon, Exciter can be used alone (in a fogger, mister or pump sprayer) and can also be used as an additive to other insecticides (Malathion, Permethrin, Cypermethrin) for the quick knock-down of insect pests. When used alone, Exciter does not have a long residual.

Always have a backup backpack. Always follow the pesticide label's instructions and not my comments or suggestions. Some of my suggestions may be illegal in some areas.





Prescription Treatment Brand Cy-Kick CS is a flowable concentrated controlled release Cyfluthrin. Simply mix 1-3 oz. per gallon of water and spray liberally along baseboards, into cracks and crevices, etc. Cy-Kick is also used as an outdoor perimeter or lawn treatment. Virtually odorless and very long lasting. Cy-Kick is the choice of many professional pest companies it is good but not cheap. It will also kill scorpions.





## Keys for Cockroach Control and/or Elimination

### Chemical Control

Cockroaches have been the target of many insecticides over the years but they have developed resistance to several of them. Attempts to use pheromones as sex lures or to sterilize male cockroaches have thus far not proved practical on a large scale.

Sprinkling abrasives such as diatomaceous earth to penetrate their protective cuticles may work in individual households as a nonpoisonous alternative. Once the cuticle is abraded, the roaches die of dehydration. Also effective is boric acid powder, which is both abrasive and poisonous to cockroaches. The best way to prevent cockroaches from multiplying is to keep a clean house and block their access to water, which they need to survive.

American cockroaches are very easy to keep and rear in the laboratory and make excellent subjects for experimentation because of their large size and generalized morphology. They have been the subject of countless studies that have tremendously increased our understanding of insect biology. At least two inoffensive species of cockroaches are kept as pets. These are the large, winged Brazilian cockroach and the Madagascar hissing cockroach.

### Treatment Methods

The disadvantage is that the treatments need to be where the roaches are hiding. Cockroaches have been seen thriving less than a foot away from a treated surface. Their path of feeding and moving to and from shelter never crossed the treated surfaces. This enabled them to live virtually on top of treated areas and yet still survive.

### Cracks and Crevice

When roaches began to build resistance to chemicals and manufacturers designed their products with less volatility, new packaging and treatment techniques became necessary. These new trends became known as "**crack and crevice**".

Basically, c/c means applying the chemical into the cracks and crevices suspected of harboring roaches. There are two types of products commonly used for this purpose: dust and aerosol. In fact, a good pest control technician should be able to get roach control with nothing more than dust if he or she knows where to do the application. **Drione Dust** has solved many roach problems. Apply it in cracks and crevices, behind cabinets and major appliances, in wall voids and electric outlets. This requires a lot of work and this product can be messy to work with, but provides the fastest results possible when used properly. Use a **Crusader Hand Duster** for the application. Since dust can be messy to work with, aerosol products became popular throughout the 1980's.

Although not as popular as when they first came out, aerosols offer a clean, ready to use formulation which is effective. PT-280 uses Orthene as an active ingredient which is still the least resistant chemical available for roach control. On a special note, don't think you can substitute Boric Acid or a can of "**Raid**" for either of the products mentioned above.

The professional line of products which is discussed are truly effective and not commonly available. Their active ingredients are effective because insects have not been able to build resistance.

There are several stories of super roaches and the fact that "**even the bugman**" couldn't get rid of "**my**" roaches, but what it all boils down to is the application method and the choice of product. If the products used are the ones as mentioned above and the treatment is thorough and complete, there is little chance of any roach surviving nor of re-infestation. Most insects, certainly roaches, cannot live where Drione has been applied. That being said, all you need to do is apply it wherever roaches want to be. This process of eliminating their nest sights eliminates their population.

Common names (the names found on the list of active ingredients) of other effective pesticides include: propoxur (Baygon), cyfluthrin, permethrin, deltamethrin, and tetramethrin. A variety of formulations may be available, including sprays (liquid or wettable powders), aerosol sprays, baits or dust. No single chemical or formulation will control all cockroaches.

Some German cockroach infestations are resistant to one or more insecticides. Apply insecticides only to cracks, crevices, or unexposed surfaces, and not beyond the point of runoff. Avoid spraying carpets, wallpapers, or other furnishings that might be stained.

The reason they appear to be "**resistant**" in most cases is that they are simply avoiding treated areas. This can happen when products are mixed at higher rates or when applicators fall victim to treating the same areas over and over again. The roaches which survive all these applications are the ones which are going where the applicator has failed to treat.

Today, these problems have been all but eliminated with the latest treating methods. These new methods are both safer and easier to do. Although spraying has long been the main method to get roach control, baiting has become a legitimate method as new baits hit the market. These products have been tested and proven effective.

### **Residual Sprays - Introduction**

These formulations are oil-based or water-based emulsions and water-based suspensions (wetable powders). They are available in ready-to-use pressurized containers or non-pressurized containers with built-in spray pumps. Residual sprays also can be purchased as concentrates to mix with water before applying with a compressed-air sprayer, plunger-type sprayer or paint brush.

Be careful when using oil-based insecticides; they may stain, dull or damage certain floor tiles, linoleum, painted surfaces, plaster, plastics, houseplants, carpets and carpet backing. Oil-based sprays can create a fire hazard when used near an open flame (pilot lights, gas stoves, furnaces). Water emulsions may stain wallpaper, light-colored carpets, draperies or other materials. They can short out electrical circuits, and are inferior to oil-based sprays on impervious surfaces such as glass or metal. Wettable powders must be frequently agitated in the spray tank, but they leave the most active residues, especially on porous surfaces such as unpainted wood, mortar or concrete block.

Residual sprays are generally easy and fast to apply. The spray should wet or dampen the treated surface; do not allow spray to puddle or run off. When treating for cockroaches, pay particular attention to cracks and crevices. Exposed surfaces, especially those used to prepare foods, should usually not be treated with sprays.



## Dusts

Insecticide dust sometimes suffices as the only treatment for cockroaches, but is most often a supplemental treatment. Dusts generally have longer residual action than sprays, but are ineffective if they become damp. Dusts are useful in cockroach control because they can be placed deep in cracks, crevices and wall voids; under refrigerators and furniture; around pipes, tunnels and conduits; on very smooth or very rough surfaces; and in other places not treatable with other formulations. Do not use dusts for treating large surfaces because they leave unsightly deposits. Also, cockroaches avoid heavy deposits and will not walk through thick layers of the material. Use light pressure on the application device to minimize the amount of dust in living areas. Apply dusts as light, even residues that are barely visible.

<b>Common active ingredients found in dust cockroach control products. This may not be a complete list and all products may not be available locally.<sup>1</sup></b>	
<i>Active ingredient</i>	<i>Examples of product names</i>
boric acid	Borid® Boric Acid Dust Enoz® Roach Away Hot Shot® MaxAttrax Roach Killing Powder Pic® Boric Acid Roach Killer III Roach Prufe®
diatomaceous earth/ silicon dioxide	Alpine® Dust Insecticide Cimexa™ Insecticide Dust Drione® (also contains pyrethrins) Mother Earth™ D Perma-Guard™ Household Insecticide D-20 (also contains pyrethrins) Safer® Ant and Crawling Insect Killer TriDie® Pressurized Silica + Pyrethrin Dust (also contains pyrethrin)

<sup>1</sup>Always read and follow directions on the product label carefully. Use only products that are labeled for in-home use.

## Baits - Detailed

Several cockroach baits are sold in ready-to use containers. They also can be made using a combination of food attractants and a toxicant. If cockroaches will not feed on the bait, the insecticide has no effect. Thus, it is important not to contaminate stored bait with organic solvents, other insecticides, fungicides and fertilizers. Baits are usually long lasting and often work well in areas that cannot be effectively sprayed or dusted. Baits are often most useful when used in conjunction with a residual spray or dust. Baits give best results in buildings where there are few alternative food supplies. Always use a sufficient number of bait containers to adequately treat an area where cockroaches are to be controlled. Examine the bait containers frequently to ensure they remain fresh and the bait is not depleted. Baits have always been available, but roaches seemed to be indifferent to them.

Although some roaches would feed and die, it was not likely that you would be able to control infestations with baits alone. Now, we have products like **Maxforce** and **Avert**. These materials are deadly for roaches.

If you spray several properties or apartments and intend on doing a lot of baiting you should consider getting the **Maxforce Bait Gun**. It uses the same **Maxforce Gel** in smaller cartridges which are loaded in the gun allowing for precise controlled applications and placements. They have been formulated with attractants which roaches cannot resist. You should be able to get complete control in homes, apartments and townhouses without having to do any spraying. The advantage of these products is that you are able to apply them with a minimum of preparation.

If you are careful, you should be able to apply Maxforce without having to remove anything from cabinets. Avert comes in an aerosol can which enables you to deliver the bait deep in wall voids where the roaches are hiding. The amazing thing about these products is that roaches love them to death.

There are videos of roaches crawling out of cabinets and wall voids in an attempt to get the bait! So attracted to these products are roaches that you only have to get them close to where the roaches are seen. They will find it. The drawbacks to these products are that they do take a little longer to work. It may take several days before you see dead roaches. Another disadvantage is that you must be careful not to spray the bait placements with traditional materials. They will contaminate the bait and roaches will simply ignore it.

In fact, roaches will ignore bait placements that have been made over treated surfaces, so make sure to apply **Maxforce** or **Avert** where you are certain no residual pesticide has been applied. In general, make your placements about 2 – 3 feet apart. In the average cabinet, you will need to make 6-8 placements with Maxforce. Since Maxforce comes out like toothpaste, it is difficult to penetrate voids with it. Use Avert for these hard to penetrate nest sites.

Avert is a different flavor than Maxforce and when the two are used together, you will get the quickest results. This is achieved because you are offering the insects a variety of food. By having two flavors available, the roaches are more likely to find one of the products. Since roaches will change their diet, having an option ensures they will find one if they don't like the other.

Active ingredient (a.i.)	Brand name	Form	Availability
abamectin	Avert	gel, powder	Professionals only
boric acid	Niban	granules	Professionals only
	Stapleton's Magnetic Roach Food	paste	Blue Diamond tel. 800 237-5705 available to homeowners
fipronil	Maxforce	bait station, gel	Professionals only
hydramethylnon	Combat	bait station, gel	Homeowners
	Maxforce	bait station, gel	Professionals only
	Siege	gel	Professionals only
indoxacarb	HotShot Maxattrax Ultra Brand Nest Destroyer Roach Bait	pellets	Professionals only
imidacloprid	Pre-Empt Professional Cockroach Gel Bait	gel	Homeowners

### Aerosols

Aerosol insecticides may or may not have residual activity. A non-residual spray alone may not provide a high degree of control, but when used with a residual spray or dust, a high degree of control can be achieved. Non-residual aerosols are useful for determining the location and extent of a cockroach infestation. Small amounts of pesticide applied to hidden areas and shelters force cockroaches to evacuate and move across previously treated surfaces. Residual aerosols should be used in the same manner as other types of residual sprays.

### Inorganic insecticides

Boric acid and powders of silica aero gel and diatomaceous earth are examples of inorganic insecticides that can be used effectively for cockroach control in homes. These chemicals are low in toxicity to humans and pets, and retain their effectiveness long after initial application. Usually, a longer period of time is required to achieve control, but reapplications are greatly reduced.

Apply boric acid, silica aero gel or diatomaceous earth in a light film to cracks and crevices and other cockroach hiding places. Avoid applications to moist or damp areas, especially when using silica aero gel or diatomaceous earth. If cockroaches become established, chemical control may be needed in combination with good sanitary practices.

**The following generic insecticides are registered for controlling cockroaches:**

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

These insecticides are sold in different formulations and under various brand names. Basic formulations available are: aerosols, baits, dusts and liquid sprays. The insecticide products must be applied in a thorough manner to all areas where roaches are located. Application may be repeated for effective control.

**Suggested insecticides and formulations for cockroach control.**

<b>INSIDE THE HOME*</b>	<b>BAITS</b>	<b>OUTSIDE AREAS</b>
Allethrin AE	Boric Acid B	Carbaryl S
Bendiocarb D	Propoxor B	Chlorpyrifos S,G
Boric Acid D, AE	Sulfuramid B	Fenvalerate S, AE
Chlorpyrifos S, D, AE	Chlorpyrifos B	Malathion S
Cyfluthrin S	Hydramethlynon B	Permethrin, S
Diatomaceous Earth D		
Deltamethrin		
Dichlorvos AE		
Fenoxycarb AE		
Fenvalerate AE		
Hydroprene AE		
Malathion S		
Methoprene S, AE		
Permethrin S, AE, D		
Phenothrin AE		
Propoxur AE		
Resmethrin AE		
Sumithrin AE		
Synergized Pyrethrins S, AE		
Tetramethrin AE		

S = spray; AE = aerosol; D = dust; B = bait; G = granules

\*Some products will have varying combinations of several active ingredients.

The reason they appear to be "**resistant**" in most cases is that they are simply avoiding treated areas. This can happen when products are mixed at higher rates or when applicators fall victim to treating the same areas over and over again. The roaches which survive all these applications are the ones which are going where the applicator has failed to treat.

**Other Methods of Control**

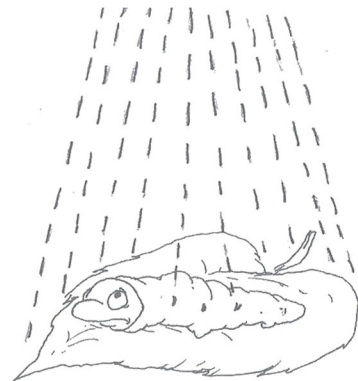
- Temperature: In some situations, temperature may be used to control cockroaches. High temperatures, for example above 125 degrees for two hours, will kill all cockroaches in an area. Of course, since cockroaches will move to a more desirable site it is important to do a whole area heat treatment. Consistently low temperatures will discourage cockroaches from establishing themselves.
- Electronic pest control devices: No electronic pest control device has been shown to be effective in controlling German cockroaches.



**INGESTED**



**REPELLENT**



**DIRECT CONTACT**



**SECONDARY CONTACT**



**LURE AND KILL**



**FUMIGANT**



## Cockroach Control Home Remedies

Here are some remedial methods and techniques that serve as best roaches repellent, and can be tried at home. Try these effectual home remedies to get rid of roaches quickly and solve your problem, how to keep away roaches permanently.

### 1. Bay Leaves

Easily available in any grocery store and a common ingredient in kitchens, and a solution for those seemingly permanent roaches, bay leaves are surprisingly effective. Leave a bundle of them near sink holes, corners and crevices where roach nests are likely to be to fend off the pests. You can also place a packet of bay leaves in cupboards to protect books and clothes from the cockroaches.

### 2. Ammonia Solution

Cockroaches often hide in sinks and drain pipes. Ammonia is a top class house hold roaches home remedy in these situations. Add a cup full of ammonia in a bucket of water and flush it down sinks and toilets to clean out the pipes. The strong pungent smell will ward off the roaches nesting in pipes and sewers.

### 3. Moth Balls

Moth balls are excellent for warding off all kinds of pests including roaches. Place a few in your cupboard and near specific areas prone to infestation or likely to be the nesting area for roaches. However, they are not good for humans either so it is important to keep them away from children.

### 4. Mint Oil

Spray mint oil directly at the pests or in sinks and corners of your kitchen and bathrooms where roaches are more likely to settle. They may not work as fast as some other home remedies, but are a natural and nontoxic way of keeping your home roaches free over time.

### 5. Listerine

Listerine not only has antiseptic properties as a mouthwash but can also be used to disinfect your house. Dilute Listerine solution with some water and spray this mixture at nests or pests or around the kitchen and bathrooms to get rid of roaches.

### 6. Cedar

Cedar can be available in the form of balls, chips or blocks to ward off all kinds of pests including roaches. One of the best roach repellents, cedar is often used to line cupboards and closets to keep these troublesome pests away.

### 7. Petroleum Jelly Trap

If you are feeling particularly creative, line the rim of a jar with petroleum jelly and leave it overnight with some food in it as a trap. The roaches will climb in for the food but will be trapped in, unable to escape because of the petroleum.

### **8. Bleach**

Bleach is one of the most common disinfectants used in the house. Mix it with water and pour it down sinks and toilets to keep your home clean and free from roaches living in drain pipes, sinks, and sewers. The bleach solution will drown away the troublesome roaches and their nests.

### **9. Lemon**

Lemon has natural anti pathogenic properties. Add lemon juice to the water you use to mop your floors, kitchen tops and bathroom cabinets to keep germs away and repel roaches that cannot stand the citric smell.

### **10. Borax**

Sprinkle borax near corners, crevices, sinks, and pipes in kitchens and bathrooms and leave it overnight. Being nocturnal creatures the roaches scurrying about at night will come in contact with the borax that dries out their exoskeletons and acts as a slow poison. Those affected by it will take it back to their nest effectively killing the other roaches too.

### **11. Soap Solution**

Make a heavy soap solution in water and throw or spray it directly at the pests. Most of them will die instantly because soap clogs their pores making it impossible for them to breathe.

### **12. Pepper, Garlic and Onion solution**

This potent mixture can be concocted by adding one tablespoon of pepper, a clove of garlic and half an onion mashed up together and added to a liter of water. Add some liquid soap if you want, and sprinkle this solution on kitchen and bathroom areas roaches frequent at night. You may also use this water to mop the floors or counter tops and cabinets. Roaches cannot stand the smell of this combination are likely to leave your home alone.

### **13. Cucumber**

Leave some cucumber slices or peels overnight around kitchen counters and cabinets or near sinks and crevices where roaches may be especially active. Cucumbers are excellent roach repellents and are a nontoxic, organic way of getting rid of these pests. You may also use cucumber along with bay leaves to ward off pesky roaches.

### **14. Boric Acid and Cornstarch or Sugar**

Use a mixture of sugar or cornstarch in addition with boric acid to kill harmful and persistent roaches. The sugar and cornstarch act as bait, attracting the roaches while the boric acid serves as poison for them, drying out their exoskeletons. This is a very effective method for getting rid of troublesome pests or a serious infestation. The only downside is the large number of dead cockroaches to clean next morning.

### **15. Coffee Trap**

Fill the bottom of a jar with ground coffee to lure in the roaches that are attracted to the smell of caffeine. Fill the jar with water so that roaches drown in it, when they try to climb into the jar. The water clogs their pores and makes it impossible to breathe. Coffee trap is great home remedy to getting rid of cockroaches.



## Fumigation Sub-Section



### Tenting

#### Fumigation

Fumigation is a pest control method that fills an entire building with fumigants that will either poison or suffocate the pests inside. It is often the only way to get rid of termites and wood boring insects that are causing extensive damage to wooden areas in a home or factory. The building to be fumigated is first completely covered with large tarpaulins or 'tents'. The fumigant is then released inside the building. The building will remain covered for a certain period of time. This allows the fumigant to penetrate all areas and kill the pests. After this, the building is ventilated so that the poison can disperse. It will then be safe for humans to re-enter the premises. The reason for the tarpaulins is to prevent the fumigant escaping and causing potential harm to neighboring people / buildings. The pest fumigation process can take up to a week to complete, depending on the level of infestation and the size of the building. Methyl bromide was the most commonly used fumigant until it was banned because it harms the ozone layer. Present day fumigants include phosphine, chloropicrin, hydrogen cyanide, methyl isocyanate, iodoform, and sulfuryl fluoride. A popular choice among many pest control services is sulfuryl fluoride. More on these fumigants in few minutes.

#### Tenting

Structural fumigating techniques differ from building to building, but in houses a rubber tent is often placed over the entire house while the pesticides are being released into the vacant residence. This process is called tent fumigation or "tenting". The sealed tent concentrates the poisonous gases and prevents them from escaping into the neighborhood. The process can take up to a week depending on the fumigant used, which in turn depend on the severity of infestation and size of the building. Fumigation is a very hazardous operation.

Generally speaking, it is a legal requirement that the operator, carrying out the fumigation operation, holds official certification to perform the fumigation as the chemicals used are toxic to most forms of life, including humans.

### **Post Operation Ventilation**

Post operation ventilation of the area is a critical safety aspect of fumigation. It is important to distinguish between the pack or source of the fumigant gas and the environment which has been fumigated. While the fumigant pack may be safe and spent, the space will still hold the fumigant gas until it has been ventilated.

### **Fumigation Application**

Application means introducing the solid, liquid or gas fumigant product into an empty space, an area containing a commodity, or a rodent burrow. In most cases with space fumigations, the fumigant is applied from outside without actually entering the structure. Application methods differ depending upon (i) the fumigant formulation being used, (ii) site/area being treated and (iii) the target pest. For example, fumigation of infested grain using a solid fumigant product may involve pellets or tablets walked into the surface of the grain, applying pellets down into the grain mass with a probe, or the use of an automatic dispenser which uniformly applies the fumigant throughout the grain mass as the bin or silo is filled. When liquid phosphine (liquefied gas or liquefied gas under pressure) is used as a fumigant, it is introduced into the treated site with approved tubing where it disperses as a gas for quick distribution throughout the fumigated area. Outdoor rodent burrows are fumigated by placing pellets or tablets into the burrow and lightly sealing the entrance/exit.

### **Structure**

“Structure” means any building regardless of its design or the type of material used in its construction, whether public or private, vacant or occupied the foundation thereof, and the adjacent enclosed areas. It shall also include but shall not be limited to warehouses, trucks, boxcars, railcars, ship holds, boxes, tarp covered stacks, other vehicles, or the contents thereof, and fumigation vaults.

### **Adjacent Enclosed Area**

A space that is located next to or near a structure that is being fumigated and has the potential for the phosphine gas to enter into and accumulate or remain in this area. If people or domestic animals may enter into this area during the fumigation or aeration process, you are required to conduct monitoring to be sure no one is exposed above the permitted level of 0.3 ppm on an 8-hour time weighted average.

### **Fumigation Management Plan**

A Fumigation Management Plan (FMP) is a written description of the steps designed to plan for a safe, legal and effective fumigation. It is important to note that some plans will be more comprehensive than others. The certified applicator and owner of the property to be fumigated must address characterization of the structure and/or area and include all safety requirements in the plan prior to application. A new FMP is not needed for every fumigation of an individual facility if conditions will not vary other than general updates such as temperature and humidity recordings. The FMP and related documentation, including monitoring records, must be maintained for a minimum of 2 years.

Although the Federal labeling allows trained workers to do certain activities associated with fumigations, some states may be more restrictive than others and require that a certified applicator always be physically present on site. Therefore, before proceeding with a fumigation, the client and/or certified applicator should consult with the State lead pesticide regulatory agency to determine regulatory status, requirements, and restrictions for use of fumigants in that state.

Most fumigation activities are carried out by a certified applicator or by a trained worker under the direct supervision of a certified applicator. As mentioned above, state restrictions and requirements vary. In some states certain specific activities can be turned over to a trained worker to complete the fumigation independently in the absence of a certified applicator. The CA may remain in voice contact if needed but not physically present.

**These Specific Activities Include:**

- ✓ Monitoring the fumigation site for gas leaks and accumulation of phosphine gas above the permitted limit
- ✓ completing the aeration of a structure after the aeration has progressed and stabilized
- ✓ removal of placards after the aeration is completed • receiving, aerating and releasing the content of a vehicle fumigated in-transit (Note: transporting vehicles under fumigation over public roads is prohibited)
- ✓ transfer of an unaerated commodity from one in-transit container to another storage site to continue with the fumigation disposal of any spent fumigant
- ✓ maintenance of written records of all permitted actions performed.

**Monitoring for Safety**

Monitoring for safety is always required unless it can be confirmed/concluded by the certified applicator that there is no possibility of exposure to phosphine at or above the allowable limits to workers or bystanders. Monitoring must be done if there is even the slightest possibility of exposure. Exposures to phosphine must not exceed the 8-hour Time Weighted Average of 0.3 ppm or the 15-minute Short-Term Exposure Limit (STEL) of 1.0 ppm.

**Under Direct Supervision**

When a fumigation product is being applied it must be under the supervision of a certified applicator. In many states “Under direct supervision” means the act or process whereby application of a pesticide is made by a competent person acting under the instructions and control of a licensee or certified applicator who is responsible for the action of that person and who is available if and when needed, even though such licensee or certified applicator is not physically present at the time and place the pesticide is applied. However, in some states certain activities as noted previously may not be performed without the physical presence of the CA.

**Voice Contact**

Voice contact means that the certified applicator (CA) is supervising the trained worker(s) by maintaining a voice communication, with or without being physically present on site. Voice contact when the certified applicator is present on-site may be accomplished by the use of phones or walkie-talkies in a situation where the CA and the trained worker are not working at a visible distance to each other (ex. when working at a large facility where several sheds or bins will be fumigated at the same time or while trouble shooting a gas leak after the fumigation has started). When both parties are not physically present on site, voice contact may be accomplished through the use of phones or walkie-talkies.

## **Safe Disposal**

Fumigation starts with the introduction of the fumigant into a space or commodity that has been properly placarded and secured. It ends when aeration has rendered the space or commodity at or below established safe limits specified in the product labeling. Safe disposal of the spent fumigant, according to label directions, must also be conducted following completion of the fumigation.

## **Fumigation Safety Rules**

Phosphine fumigants are valuable tools as long as they are used properly. Read and follow all instructions on the label, including the applicator's manual to ensure a safe and effective fumigation. Store all containers of fumigant under lock and key, and keep a careful inventory so each container and package is accounted for. If you discover that any fumigant has been stolen, you are required to report the theft immediately to your local law enforcement authorities. Make sure the storage area is properly placarded as a pesticide storage area.

The applicator's manual specifies what must be on the placards for an area where phosphine fumigants will be stored. Never store fumigants inside a home or in any structure where humans or animals live. Just-in-time delivery of exactly the right amount of fumigant is the safest practice.

If you have to transport fumigants, keep the container(s) locked in a metal box in your truck bed. If you transport large quantities on a regular basis, you may want to consider a security system. The applicator's manual lists the hazards associated with transporting aluminum phosphide. Be aware of these hazards and have a list of them with you in the truck. Your truck will need to display a placard providing information about aluminum phosphide. If you are carrying less than 46 pounds of fumigant, you may be eligible for a placarding exemption, such as exemption DOT E 11329 (<http://hazmat.dot.gov>).

## **Important Reminders**

All fumigants are dangerous, and their use requires specific training. All fumigants are restricted-use pesticides for application by trained and certified pesticide applicators only. This publication is intended to assist applicators who meet these requirements. It is always advisable, however, to consider using the services of a professional commercial fumigator to reduce both risk and liability.

## **Use fumigants according to the directions on the label.**

Follow all directions, precautions, and restrictions that are listed. Do not use fumigants on commodities or sites that are not listed on the label. The fumigant rates listed in this publication are recommended only for those fumigants registered with the Environmental Protection Agency and the pertinent state department of agriculture. If the label is cancelled or changed, the information contained herein is no longer recommended.

## **Respiratory Protection**

For personal protection against the vapors of phosphine at concentrations above the threshold limit, a respirator or other similar equipment for supplying uncontaminated air must be used. Respirators with a special canister for phosphine vapors will give protection up to 0.5 percent phosphine by volume in air (Kloos et al, 1966). Above this concentration, air must be supplied by an air-line or self-contained breathing equipment. Appropriate detection equipment for measuring concentrations of phosphine in air should be used in conjunction with respiratory protective devices to ensure adequate protection.

### **General Precautions**

Full precautionary instructions are supplied by the manufacturers of the proprietary materials used for generating phosphine. Some of the more important precautions are listed here.

1. Gloves should be worn when tablets or pellets are being dispensed by hand.
2. Respirators need not be worn when tablets or pellets are being dispensed under conditions where the operator does not breathe the vapors of phosphine. Under normal conditions, there is a delay in evolution of the fumigant from the formulations described in this manual. Respirators equipped with a canister designed for protection against phosphine (see above) or other appropriate respiratory equipment should always be on hand in case of emergency.
3. Odor of the fumigant cannot be relied upon as an indication of whether or not the operator is breathing poisonous concentrations. Detection equipment such as glass detector tubes or other detectors should be used to monitor concentrations of the gas and to determine when an area is free of fumigant after a treatment.
4. Do not smoke or touch food at any time during the application of this insecticide.
5. Any spaces adjoining silo bins or close to other structures undergoing treatment with phosphine should be kept continuously aired by leaving windows open or by providing artificial ventilation by means of fans or blowers.
6. All persons working, or likely to work, in any place near the fumigation area must be notified that fumigation is in progress. Warning notices should be posted to prevent exposure of employees or the public at large to the gas.
7. When the fumigation is completed and the grain is turned, or aeration of a structure is undertaken, full precautions must be undertaken to ensure that no person is exposed to residual vapors of the fumigant.



## **Pesticide First Aid**

### **Symptoms of Poisoning**

According to the amount of phosphine inhaled, symptoms may occur immediately or several hours after exposure. Slight or mild poisoning may give a feeling of fatigue, ringing in the ears, nausea, pressure in the chest and uneasiness. All of these symptoms will normally disappear in fresh air. Greater quantities will quickly lead to general fatigue, nausea, gastrointestinal symptoms with vomiting, stomach ache, diarrhea, disturbance of equilibrium, strong pains in the chest and dyspnea (difficulty in breathing).

Very high concentrations rapidly result in strong dyspnea, cyanosis (bluish-purple skin color), agitation, ataxia (difficulty in walking or reaching), anoxia (subnormal blood oxygen content), unconsciousness and death. Death can be immediate or occur several days later due to edema and collapse of the lungs, paralysis of the respiratory system or edema of the brain. Disturbances of kidney and liver functions (haematuria, proteinuria, uremia, jaundice) and cardiac arrhythmia may occur.

### **Advice to the Physician**

The following measures are suggested by the manufacturer for use by the physician in accordance with his own judgment.

In its milder forms, symptoms of poisoning may take some time (up to 24 hours) to make their appearance, and the following measures are suggested:

1. Complete rest for one or two days, during which the patient is kept quiet and warm.
2. Should the patient suffer from vomiting or increased blood sugar; appropriate intravenous solutions should be administered. Treatment with oxygen breathing equipment is recommended as is the administration of cardiac and circulatory stimulants.

In cases of severe poisoning intensive care in a hospital is recommended:

1. Where pulmonary edema is observed, steroid therapy should be considered and close medical supervision is recommended. Blood transfusions may be necessary.
2. In case of manifest pulmonary edema, venesection should be performed under vein pressure control, and intravenous administration of glycosides (in case of haemoconcentration, venesection may result in shock). On progressive edema of the lungs, perform immediate incubation with constant removal of edema fluid and establishment of oxygen positive pressure respiration, as well as any measures required for shock treatment. In Case of kidney failure, extracorporeal hemodialysis is necessary. There is no specific antidote known for this poison.
3. Suicide may be attempted by taking solid phosphides by mouth. In such a case, empty the stomach by inducing vomiting and flush it with a dilute potassium permanganate solution or a solution of magnesium peroxide until the flushing liquid ceases to smell of carbide. Thereafter, administer medicinal charcoal.
4. Scientific research has shown that phosphine poisoning is not chronic; the action of phosphine is reversible and symptoms will disappear by themselves.

### **Health Effects & Toxicity**

Fumigant pesticides also are among the most toxic chemicals used in agriculture. The U.S. EPA categorizes most fumigants as "highly acutely toxic"-- the agency's most extreme toxicity category.

### **Acute Fumigant Poisoning**

Acute fumigant poisoning causes eye irritation, sore throat, headaches, nausea, vomiting, breathing difficulties and aggravated asthma, and neurological effects such as convulsions, dizziness, or tremors.

**Fumigant exposure also has long-lasting effects that include, many applicators will die from these...**

#### **Cancer**

Several fumigants are known carcinogens, including methyl iodide, 1,3-Dichloropropene, and metam sodium; all of which are included in California's Proposition 65 carcinogen list.

#### **Respiratory Damage**

Exposure to fumigants can cause permanent respiratory damage. In lab animals chronically exposed to chloropicrin, researchers observed permanent damage to the bronchial tree, as well as lung cancer and tumors. The CDC classifies chloropicrin as a "lung damaging agent," noting that poisoning can cause a lethal pulmonary edema.

#### **Neurological Effects**

Methyl bromide and methyl iodide are both potent neurotoxins. Exposure to methyl bromide adversely affects cognitive function, physical coordination and muscular control (Extension Toxicology Network).

- Reproductive & developmental effects: Some fumigants are linked to elevated risk of miscarriage. In animal studies, fetal survival rate was significantly reduced from methyl iodide exposure.
- Immune system effects: Research shows that exposure to metam sodium and its breakdown product, methyl isothiocyanate, can weaken the human immune system.
- Endocrine Disruption: Fumigants are known to interfere hormones. In laboratory studies the fumigant metam sodium suppressed hormones that control ovulation and also increased stress hormones. Methyl iodide disrupts thyroid hormones critical for fetal development, resulting in increased miscarriage and developmental delays research shows.

#### **Poisonings & Drift**

The volatility of fumigants makes them inherently dangerous. Communities and farmworkers near agricultural fields face serious risks of acute pesticide poisoning from drifting fumigants. Fumigant drift has also been measured in air far from application sites, sometimes at levels above those considered "acceptable" for longer-term seasonal exposures by EPA or the California Department of Pesticide Regulation. Results from PANNA's Drift Catcher project in Sisquic, California showed that residents were exposed to levels of chloropicrin that exceeded California's acute level of concern for children.

#### **Every few years there is a mass fumigant poisoning:**

- In November 1999, drifting metam sodium poisoned an entire neighborhood in Earlimart, California, resulting in the evacuation of 150 people from their homes. One Earlimart resident recalled that she first noticed something was wrong when her infant son's eyes began to tear.
- In October 2003, a plume of chloropicrin drifted into the California community of Lamont after being applied to a nearby onion field. 150 residents were poisoned. Despite the widespread illness, application of the pesticide was continued the next day and 100 more people were affected.



## Fumigants Detailed

### Phosphine

Phosphine (IUPAC name: phosphane) is the compound with the chemical formula  $\text{PH}_3$ . It is a colorless, flammable, toxic gas. Pure phosphine is odorless, but technical grade samples have a highly unpleasant odor like garlic or rotting fish, due to the presence of substituted phosphine and diphosphine ( $\text{P}_2\text{H}_4$ ). With traces of  $\text{P}_2\text{H}_4$  present,  $\text{PH}_3$  is spontaneously flammable in air, burning with a luminous flame. Phosphines are also a group of organophosphorus compounds with the formula  $\text{R}_3\text{P}$  (R = organic derivative). Organophosphines are important in catalysts where they complex to various metal ions; complexes derived from a chiral phosphine can catalyze reactions to give chiral products.

### Forms

Phosphine fumigants are sold in solid form, either as aluminum phosphide or magnesium phosphide. This publication focuses on aluminum phosphide that is sold under various brand names including Phostoxin, Phosfume, and Weevilcide. Aluminum phosphide can be used to eliminate insect infestations in a variety of commodities, including animal feed and feed ingredients, corn, cottonseed, grass seed, millet, oats, peanuts, pecans, popcorn, rye, sorghum, soybeans, triticale, and wheat. They can also be used for a variety of processed foods as long as the residue dust does not come in direct contact with the product. They can be used on some nonfood commodities including straw and hay, cotton, feathers, tobacco, dried plants and flowers, and seeds. The fumigant label contains a complete list of commodities that can be fumigated. Phosphine fumigants can be used in a variety of structures including grain bins and silos, rail cars, warehouses, and flat storage structures.

Aluminum phosphide is packaged as tablets about 5/8 inch in diameter, as pellets about 3/8 inch in diameter, or as granules in a sachet or small, porous bag. Tablets release about five times more phosphine gas than pellets release. At high temperatures, it may be safer to use tablets because they break down slower than pellets. If you are fumigating a raw agricultural commodity, you can use tablets or pellets, without removing the residue. For processed commodities, prepacs, ropes, or blankets, keep the residue within the packaging so it can be removed after the fumigation. Pest fumigation is a dangerous operation. It must be carried out by competent personnel or registered pest control companies that are in possession of the correct certification that allows them to perform pest fumigation operations.

### Monitoring Done

There are a number of devices on the market for the measurement of phosphine gas. The devices range from glass tubes to electronic equipment. Knowledge of the use and limitations of such devices are part of the training program for fumigation workers. Registrants of phosphine products also serve as an additional source for information on these devices.

Make sure all employees know about the fumigation and are aware of potential safety hazards and emergency procedures. Make a list of the telephone numbers and addresses of the nearest fire department, rescue squad, hospital emergency room, and police department, and notify each agency of the fumigation ahead of time. Include on the list the names and telephone numbers of all appropriate personnel in charge. Provide each agency with a copy of your fumigation management plan and any other information needed in case of an emergency.

This information should include the Material Safety Data Sheet (MSDS) for the phosphine fumigant used and a copy of the label, including the applicator's manual. There may be local requirements in addition to those in the applicator's manual and label. As you work your way through notifying the above agencies, you may learn of additional requirements. Accidents involving aluminum phosphide are rare — but in case the worst happens, a well-informed emergency response team would have a greater chance of saving your life than one that has not been informed about the hazards of aluminum phosphide.

A certified applicator is someone who has passed a state exam. Individuals receiving specific instructions in documented training sessions are classified as trained applicators. One certified applicator and another trained person are the minimum personnel required when aluminum phosphide is applied. Two trained people can legally make the application, as long as they are under the direct supervision of the certified applicator. All should carry some form of communication device, such as a radio, a walkie-talkie, or a cellular phone. See the applicator's manual for requirements after the application.

You cannot follow label instructions without knowledge of the phosphine gas concentration during the fumigation process. One possible exception would be an isolated farm bin location on private property. The label requires that you keep a log showing phosphine gas concentration at key locations surrounding the structure. The type of respiratory equipment used depends on the gas concentration. Furthermore, it makes sense to monitor the gas inside the structure (using extension hose from a safe outside location) to make sure an insect-lethal concentration of gas is present

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used.



Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them.

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

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

### **Chloropicrin**

Some trade names for products containing chloropicrin include "Chlor-O-Pic," "Metapicrin" "Timberfume" and "Tri-Clor." A partial list of trade names for chloropicrin mixtures with methyl bromide includes "Tri-Con," "Terr-O-Gas," "Preplant Soil Fumigant" and "Pic-Brom." Chloropicrin mixtures with 1,3-Dichloropropene include "Telone C-17," "Tri-Form" and "Pic-Clor."

### **Regulatory Status**

Chloropicrin is currently undergoing USEPA FIFRA reregistration. It is a Class I toxicity, Restricted Use Pesticide (RUP), labeled with the signal word "Danger". The U.S. Department of Transportation (DOT) proper shipping name is "Chloropicrin, 6.1, UN 1580, PGI, Poison Inhalation Hazard, Hazard Zone B." The Emergency Response Guide (ERG) number is 56. NFPA designations are 4-Health, 0-Fire, 3-Reactivity. Chloropicrin is not listed under the EPA Clean Air Act, EPA Clean Water Act or the EPA Marine Pollutant List. A tolerance is not required for pre-plant soil fumigation uses of chloropicrin.

### **Description**

Chloropicrin is a clear, colorless, oily liquid with a strong, sharp, highly irritating odor. It is a strong lachrymator. Chloropicrin has been used as an insecticide since 1917 and as a soil fumigant since 1920. The primary use today is for preplant soil fumigation to control soil borne fungi, diseases and nematodes. It also is used to treat wood poles and timbers for internal decay by fungi and insects; as a warning/clearing agent for sulfuryl fluoride (structural fumigant) and methyl bromide (soil and structural fumigant); and is also used in organic synthesis.

For soil fumigation and wood treatment, chloropicrin is packaged in DOT 4BW240 steel cylinders and bulk tanks which may be pressurized. When used as a warning agent for methyl bromide, chloropicrin is packaged along with the methyl bromide in steel cylinders. When used as a structural fumigation warning agent for sulfuryl fluoride, chloropicrin is packaged in small plastic bottles in DOT approved overpacks.

Chloropicrin has a moderate vapor pressure (18.3 mmHg at 20 degrees C) and exists as a liquid at room temperature. Chloropicrin/methyl bromide mixtures will volatilize readily upon opening of the cylinder valve. Materials incompatible with chloropicrin are PVC, fiberglass, aluminum and magnesium and their alloys. Pest fumigation is a dangerous operation. It must be carried out by competent personnel or registered pest control companies that are in possession of the correct certification that allows them to perform pest fumigation operations.

## **Soil Fumigation**

Chloropicrin is injected as a liquid into the soil approximately 6-10 inches below the surface, 14 days or more before crop planting. It kills target fungi within 48 hours of application. Chloropicrin also controls some root-destroying nematodes, soil insects, and other plant-limiting pests. The importance of soil fumigation in the control of plant pathogens cannot be overstated. Even in agricultural soil with adequate nutrients, water and oxygen, plant growth and crop yields can decline over time due to increasing levels of pathogenic fungi and other pests. In the 1950s, before soil fumigation with chloropicrin, California strawberry growers resorted to applying 500 pounds/acre or more of nitrogen because of plummeting crop yields. The problem was not lack of soil nutrients--it was lack of healthy roots. Strawberry root diseases were widespread at the time and the partially rotted roots were not capable of absorbing the abundant nitrogen that was available. By making high crop yields predictable and at the same time reducing the use of fertilizers, chloropicrin/MeBr combinations have made it possible to replant the same fruit and vegetable land year after year. Predictable crop yields have allowed breeders to concentrate their efforts on fruit quality, appearance, and shipability.

Environmentally, chloropicrin does not have a significant ozone depletion potential because it undergoes rapid breakdown in sunlight. It is metabolized in soil to carbon dioxide. Under anaerobic/aquatic conditions, chloropicrin is converted to nitromethane within hours. In a plant metabolism study utilizing soil treated with radiolabelled chloropicrin, no chloropicrin or nitromethane was detected in any plant tissue or harvested produce.

## **How is chloropicrin used?**

Extremely small quantities are used as part of the fumigation process, at concentrations that provide adequate warning without causing lingering odors or other adverse effects for home owners or the environment.

## **How is chloropicrin released into a home?**

The fumigator carefully measures and pours the chloropicrin onto an absorbent material in one or more shallow pans. The pans are then placed near fans in the area where Vikane will be released. Air movement from the fans helps evaporate the chloropicrin and distribute it throughout the structure. Chloropicrin is released at least five to ten minutes before introducing Vikane to make sure it has sufficient time to act as a warning agent within the structure.

You as the fumigator shall conduct a walk-through inspection to help confirm everyone is out of the structure prior to releasing chloropicrin. You as the fumigator shall also post warning signs around the structure to help prevent early or accidental re-entry. In addition, you as the fumigator shall use secondary locks on the entrances of your home that requires a special key to gain access to help ensure the structure remains free of people throughout the fumigation process.

## **Is the amount of chloropicrin used during the fumigation harmful to people?**

Should I be concerned about it affecting my health? According to the product label, chloropicrin is used at very low application rate of 1 fluid ounce for every 10,000 to 15,000 cubic feet of fumigation space.

This results in a controlled concentration of chloropicrin within the structure during the fumigation. After the fumigation period, your fumigator will aerate the Vikane and chloropicrin down to DPR accepted levels acceptable for you to re-enter the home.

Once clearance has taken place, the amount of chloropicrin remaining in the home is at such a low level that homeowners need not to be concerned with any toxicological effects.

**What should I do if I sense chloropicrin or experience symptoms after the fumigation?**

Minute amounts of chloropicrin remaining in the structure may cause tearing, a scratchy throat or coughing. Although every effort is made to clear chloropicrin from your home, it may still be detectable at extremely low concentrations. Even if you sense chloropicrin immediately following the fumigation of your home, a small amount of chloropicrin does not mean Vikane is still present.

Vikane aerates from structures more rapidly, and fumigators use sensitive detection equipment to ensure that Vikane is cleared from your home prior to allowing re-occupancy. A few simple steps can assist in clearing any remaining chloropicrin from a home. A small amount of chloropicrin does not mean Vikane is present.

It is recommended that you as the fumigator shall complete the next steps: Retest to confirm is cleared from your home. Open windows. Operate fans of air-handling systems such as heat or air conditioning. Place additional fans near windows to create a directed air flow through the structure for efficient aeration. Increase the temperature within the structure by turning off the air cooling compressors of air conditioners in the warmer months (operating the fan only) and using the central heating system in the cooler months. The above steps may require a few hours for the fumigator to complete. Leave the structure during this time if you continue to experience irritation from chloropicrin.



## Hydrogen Cyanide (HCN)

Hydrogen cyanide is one of the most toxic of insect fumigants, many applicators and customers alike have died from this chemical. I know of one applicator that went to prison for not following the label instructions. I know another person whose son died from the effects of a poor treatment/ventilation method. The fact that Hydrogen cyanide is very soluble in water has considerable bearing on its use in practice. Thus, it may produce injury on moist materials, such as fruit and vegetables, because the solution of HCN in water is a dilute acid. Not only does this acid render these materials unpalatable and possibly hazardous for human consumption, but its action, by causing burning, wilting or discoloration, may make them unmarketable.

On the other hand, HCN has been widely used for fumigating dormant nursery stock that is sufficiently dry. It may be used for some living plants if they can be washed with water immediately after treatment to prevent burning by the acid.

HCN may be employed for fumigating many dry foodstuffs, grains and seeds. Although HCN is strongly sorbed by many materials, this action is usually reversible when they are dry, and, given time, all the fumigant vapors are desorbed. With many foodstuffs little, if any, chemical reaction occurs, and there is no detectable permanent residue. Because of the high degree of sorption at atmospheric pressure, HCN does not penetrate well into some materials. It WAS largely because of this that vacuum fumigation was adopted. Pest fumigation is a dangerous operation. It must be carried out by competent personnel or registered pest control companies that are in possession of the correct certification that allows them to perform pest fumigation operations.

### **Toxic**

HCN is a powerful, quick acting poison. In humans and other warm-blooded animals, it induces asphyxiation by inhibiting the respiratory enzymes and renders tissues unable to absorb oxygen from the blood in the normal manner.

The toxic action is reversible. In practice, this means that a person who is completely unconscious from the effects of cyanide, but whose heart is still beating, may still recover if suitable antidotes and remedial measures are applied in time. HCN may be absorbed in toxic amounts through the unbroken skin (see below under "Precautions").

### **Toxicity to Insects**

Among the commonly used fumigants, HCN is one of the most toxic to insects. It also has a rapid paralyzing effect on most species. This action is an important consideration in dealing with insects, because sub-lethal concentrations may bring about apparent death. After exposure to the fumigant, the reversible action of the poison may permit the insect to recover.

This reaction has already been referred to as protective stupefaction (Lindgren, 1938). It is important from the practical point of view because it means that the maximum recommended concentration should be attained as quickly as possible during the application of the fumigant.

### **Flammability Limits**

The flammability limits of HCN in air lie between 6 and 41 percent by volume. These limits are well above the normally recommended fumigation doses of up to 1.5 percent (16 g/m<sup>3</sup> or 16 oz/l 000 ft<sup>3</sup>). However, it must be pointed out that, at the point of release of the gas at the beginning of a fumigation, a concentration within these limits may exist for a short length of time. If there is any flame (such as a pilot light) or sparks near temporary high concentrations, a serious fire or explosion could occur. In working with this fumigant, great care must be exercised to extinguish all flames and turn off all electric switches before a treatment begins.

### **Precautions**

#### **Respirators**

Respirators fitted with the canister for acid gases will give protection against HCN and must be worn during all operations in which there is exposure to any concentration of this gas.

#### **Absorption through Human Skin**

HCN may be absorbed in toxic amounts through the unbroken skin; the amount is increased if the skin is moist. With modern fumigation techniques it is unnecessary for an operator to remain in a full fumigation concentration of HCN. The fumigant is either discharged from cylinders outside the structure or the gas is generated indoors by one of the methods described above. In the second type of operation, workers who apply granular calcium cyanide or HCN discs, or who initiate generation by dropping sodium cyanide into acid, are able to move away before a heavy concentration of fumigant builds up. During the aeration process it is usually possible to open some doors and windows from outside the structure and to start exhaust fans and blowers so that the full concentration of HCN in the air may be reduced before any person goes inside.

Although the industrial-type respirator canister will remove concentrations of HCN in air up to 2 percent by volume for a limited length of time, it is recommended, in order to avoid absorption of dangerous amounts through the skin, that persons wearing respirators do not remain for more than 5 minutes in concentrations of 0.75 percent or for more than 20 minutes in concentrations of 0.5 percent.

#### **Symptoms of HCN Poisoning**

Unless a person is immediately overcome by an overpowering concentration of HCN, a situation unlikely to be encountered in fumigation work when proper precautions are taken, there are preliminary symptoms which serve as a warning of poisoning. These symptoms are common to poisoning caused both by breathing HCN or by its absorption through the skin.

#### **More common warning symptoms of HCN Poisoning are:**

- irritation of the mucous membrane of the eyes, throat and upper respiratory tract;
- burning sensation on the tongue;
- metallic taste in the mouth
- feeling of pressure in the forehead;
- sharp pains in the head;
- giddiness and disturbed equilibrium;
- nausea and vomiting

If any of the foregoing, or related symptoms are experienced while a person is in the presence of HCN in any concentration, he should move immediately into fresh air, preferably where it is warm, and, if necessary, undergo the first aid treatment outlined below.



Although the poisonous action of HCN is rapid, a person may live for several hours after being completely overcome (Chen et al, 1935). Thus, even if there is some delay in the application of remedial treatments by the physician, it may still be possible to bring about the recovery of the patient.

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

### **Methyl Iodide**

Methyl iodide is the proposed replacement for methyl bromide, is in fact more toxic than its predecessor. Pest fumigation is a dangerous operation. It must be carried out by competent personnel or registered pest control companies that are in possession of the correct certification that allows them to perform pest fumigation operations.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

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

### **Methyl Isocyanate (MIC)**

Methyl isocyanate is an organic compound with the molecular formula  $C_2H_3NO$ , arranged as  $H_3C-N=C=O$ . Synonyms are isocyanatomethane, methyl carbylamine, and MIC. Methyl isocyanate is an intermediate chemical in the production of carbamate pesticides (such as carbaryl, carbofuran, methomyl, and aldicarb). It has also been used in the production of rubbers and adhesives. As a highly toxic and irritating material, it is hazardous to human health, and was involved in the Bhopal disaster which killed nearly 8,000 people initially and approximately 17,000 people in total. Methyl isocyanate is an intermediate chemical in the production of carbamate pesticides (such as carbaryl, carbofuran, methomyl, and aldicarb). It has also been used in the production of rubbers and adhesives.

Methyl isocyanate (MIC) is extremely toxic. The threshold limit value set by the American Conference on Government Industrial Hygienist was 0.02 ppm. MIC can damage by inhalation, ingestion and contact in quantities as low as 0.4 ppm. Damage includes coughing, chest pain, dyspnea, and asthma, irritation of the eyes, nose and throat, as well as skin damage.

Higher levels of exposure, over 21 ppm, can result in pulmonary or lung edema, emphysema and hemorrhages, bronchial pneumonia and death. Although the odor of methyl isocyanate cannot be detected at 5 ppm by most people, its potent lachrymal properties provide an excellent warning of its presence (at a concentration of 2–4 parts per million (ppm) subject's eyes are irritated, while at 21 ppm, subjects could not tolerate the presence of methyl isocyanate in air).

Proper care must be taken to store methyl isocyanate because of its ease of exothermically polymerizing (see Reactions) and its similar sensitivity to water. Only stainless steel or glass containers may be safely used; the MIC must be stored at temperatures below 40 °C (104 °F) and preferably at 4 °C (39 °F).

The toxic effect of the compound was apparent in the Bhopal disaster, when around 42,000 kilograms (93,000 lb.) of methyl isocyanate and other gases were released from the underground reservoirs of Union Carbide India Limited (UCIL) factory, over a populated area on December 3, 1984, immediately killing thousands and leading to the deaths of tens of thousands in subsequent weeks and months.

### **Iodoform**

Iodoform is the organoiodine compound with the formula  $\text{CHI}_3$ . A pale yellow, crystalline, volatile substance, it has a penetrating odor (in older chemistry texts, the smell is sometimes referred to as the smell of hospitals) and, analogous to chloroform, sweetish taste. It is occasionally used as a disinfectant. It is sometimes also referred to as carbon triiodide (which is not strictly correct, as this compound also contains hydrogen) or methyl triiodide (which is somewhat ambiguous as that name could also refer to the methylated triiodide ion,  $\text{CH}_3\text{I}_3$ ). Pest fumigation is a dangerous operation. It must be carried out by competent personnel or registered pest control companies that are in possession of the correct certification that allows them to perform pest fumigation operations.

The compound finds small scale use as a disinfectant. Around the beginning of the 20th century it was used in medicine as a healing and antiseptic dressing for wounds and sores, although this use is now superseded by superior antiseptics. Adolf Hitler's mother, Klara Hitler, died of iodoform poisoning brought on by her treatment for breast cancer. It is the active ingredient in many ear powders for dogs and cats, to prevent infection and facilitate removal of ear hair, along with zinc oxide and propanoic acid.

### **Formaldehyde**

Formaldehyde is an organic compound with the formula  $\text{CH}_2\text{O}$ . It is the simplest aldehyde, hence its systematic name methanal. Formaldehyde is a colorless gas with a characteristic pungent odor. It is an important precursor to many other chemical compounds, especially for polymers. In 2005, annual world production of formaldehyde was estimated to be 23 million tons (50 billion pounds). Commercial solutions of formaldehyde in water, commonly called formalin, were formerly used as disinfectants and for preservation of biological specimens. In view of its widespread use, toxicity and volatility, exposure to formaldehyde is a significant consideration for human health. On 10 June 2011, the US National Toxicology Program has described formaldehyde as "known to be a human carcinogen".

### **American Cockroaches Invincible**

American" adult cockroaches can survive exposure to various forms of fumigation, including formaldehyde fumigation that is carried out at double strength and for four times as long as is recommended for disinfection of rooms. It is further reported that vaccinia virus ingested prior to the fumigation survives in the cockroach gut and may be excreted up to 5 days later. Since cockroaches are ubiquitous and are to be found in most hospitals, laboratories and animal houses, these findings should be considered whenever fumigation is called for.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

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

### **Sulfuryl Fluoride**

Sulfuryl fluoride has the ability to kill pests at any stage of their lives, including eggs. It does not harm the ozone layer and it is not associated with the dangers of phosphine. Sulfuryl fluoride is used widely as a pest fumigant to control dry wood termites that thrive in warm climates. It is also effective for the eradication of bark beetles, powder post beetles, rodents and bed bugs. Sulfuryl fluoride is the inorganic compound with the formula  $\text{SO}_2\text{F}_2$ . This easily condensed gas has properties more similar to sulfur hexafluoride than sulfuryl chloride, being resistant to hydrolysis even up to 150 °C. So inert is this material that suspended molten "sodium metal retains its shiny metallic appearance." Use of  $\text{SO}_2\text{F}_2$  as a fumigant has increased rapidly as it replaces methyl bromide, now being phased out because of harm to the ozone layer, and as an alternative to the risks of phosphine.

Originally developed by the Dow Chemical Company, sulfuryl fluoride is in widespread use as a structural fumigant insecticide to control drywood termites, particularly in warm-weather portions of the southwestern and southeastern United States and in Hawaii. Less commonly, it can also be used to control rodents, powderpost beetles, bark beetles, and bedbugs.

Sulfuryl fluoride is currently marketed by three distinct manufacturers, under four different brand names. Vikane (Dow) (EPA Reg. No. 62719- 4-ZA) has been commercially available since the early 1960s, with Zythor (marketed by competitor Ensystem of North Carolina) (EPA Reg. No. 81824- 1-AA) being more recently introduced gradually as its use is approved by individual states (in Florida circa 2004, but not in California until October 2006, for example).

Dow recently has begun marketing sulfuryl fluoride as a post-harvest fumigant for dry fruits, nuts, and grains under the trade name ProFume (EPA Reg. No. 62719- 376-AA). Most recently Drexel Chemical Company has registered Master Fume (EPA Reg. No. 19713-596-AA) for the structural market, competing against Vikane and Zythor.

Pest fumigation is a dangerous operation. It must be carried out by competent personnel or registered pest control companies that are in possession of the correct certification that allows them to perform pest fumigation operations.

## **Other Fumigation Treatments**

### **Demon WP**

Demon WP is used against a variety of insects and commonly used to control cockroaches. It is an odorless chemical which provides up to 90 days of protection. The active ingredient in Demon WP is Cypermethrin 40.0%; it may be used inside or outside of the house. The chemical is acceptable for use in federally licensed meat, poultry and egg processing plants. Demon WP will not hold up in a water solution. A gallon of Demon WP will cover 2,000 to 2,500 square feet of home or business space. It will not damage or stain any plastic, varnished or painted surface where it is applied.

### **Cyonara 9.7**

Cyonara 9.7 is a multi-purpose pesticide commonly used for fumigating cockroaches. It is suitable for use indoors and outdoors in homes, commercial establishments, agricultural areas and food handling areas. The active ingredient in Cyonara 9.7 is 9.7% Lambda-Cyhalothrin, and the pesticide will last up to seven months when applied. Do it Yourself Pest Control recommends reapplying every two to three months to ensure effectiveness. In concentration, one quart of Cyonara 9.7 produces between 39 to 157 gallons of usable pesticide. A typical house needs from 1 to 2 gallons for a proper fumigation.

### **Cyper WP**

Cyper WP comes in a white powder and is mixed with water. When applied, the mixture lasts between two and three months with a 1-pound container producing about 24 to 48 gallons of cockroach fumigation chemicals. A 1-pound container will cover 2,000 to 2,500 square feet of commercial or residential space. The product is odorless and suitable for use indoors or outdoors, but will leave a powder chemical residue on dark furniture or dark surface spaces. It is suitable for use in residential, commercial, agricultural and industrial spaces. In conditions where it rains often, the product should be applied more regularly. The chemical is toxic to fish, so any fish tanks should be covered before application.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

### Topic 3 - Cockroach Inspection and Treatment Section Post Quiz

Fill in the missing part. The answers are in the rear near the glossary.

1. The single most important factor in determining cockroach survival is availability of this missing term.
2. The elimination of these harborages (clutter) is important in controlling this missing term.
3. Cockroaches prefer bare wooden surfaces, cardboard or paper because these surfaces are easier to climb and because porous surfaces retain which missing term.
4. Return every \_\_\_\_\_ days and inspect cockroach traps.
5. Which missing term is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices?
6. Which missing term type of pesticides are generally only used as required and often only at specific times in a pests' life cycle?
7. Caulking or puttying areas such as \_\_\_\_\_ around kitchen cabinets, bathtubs, water and plumbing pipes, cracks on floors and walls, and exterior windows and doors can eliminate most hiding places and help reduce the cockroach population.
8. Which missing term sometimes suffices as the only treatment for cockroaches, but is most often a supplemental treatment?
9. Which missing term alone may not provide a high degree of control, but when used with a residual spray or dust, a high degree of control can be achieved?
10. The active ingredient in which product is Cypermethrin 40.0%; it may be used inside or outside of the house?



## Topic 4 –Advanced Cockroach Management Section Cockroach Management Strategies

**Topic 4- Section Focus:** You will learn the fundamentals of advanced cockroach control intergraded pest management, including various difficult cockroach control application/elimination methods. At the end of this section, you the student will be able to understand and describe advanced cockroach control management 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 4- Scope/Background:** Many types of insecticides are available for controlling cockroaches. Most are sold as liquid or aerosol sprays, while some are formulated as edible baits or dusts. Always read and follow product instructions. This will help you to achieve optimal results while using the product safely. Many insecticides require the removal of food and utensils from treated areas. Removing such items often makes areas more accessible for treatment and prevents possible contamination by the insecticide.

### Specific Insecticide Chemical Information - Introduction



#### Introduction - Pesticide Safety Review

*Before we start, we need to review various important information. This information may seem unnecessary, however, sadly, many pesticide professionals end up losing their jobs, or being sued or even facing criminal damages from improper pesticide application or recordkeeping.*

### Pesticides are Toxic Compounds

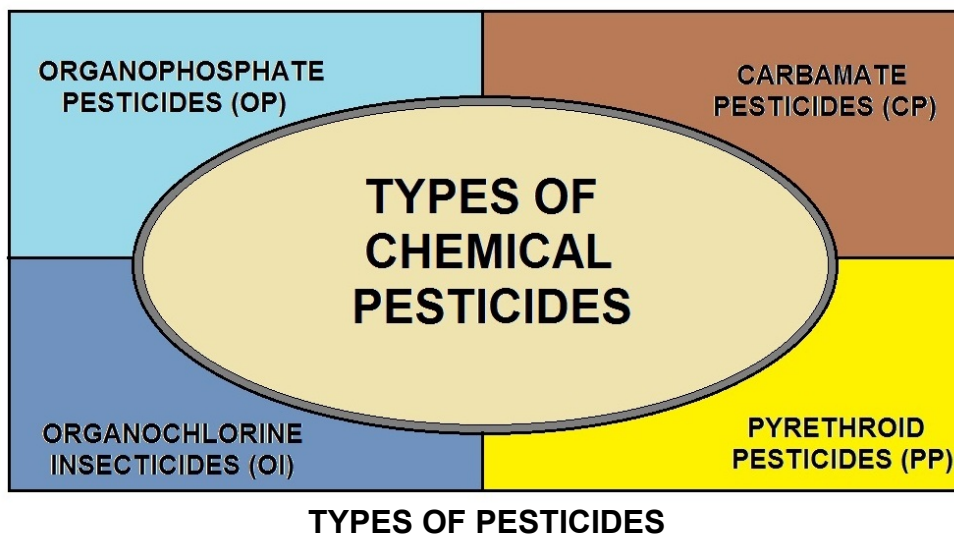
Pesticides are dangerous to people and animals because the toxic compounds can kill or unfavorably affect the living matter. Pesticides bear dangers to customers and workers during production, transportation, and application of these substances.

### Agricultural Pesticide Residues

Fruits and vegetables often contain residues that contaminate and poison them. Pesticides dangers waylay people everywhere and the victims may be exposed to chemicals while consuming contaminated foods or during pesticide spraying.

### Pesticide Danger to Health Loading

Numerous are diseases associated with severe pesticide toxicity and resultant pesticide dangers. Children are innocent victims facing the greatest pesticides dangers. The pesticide health load is difficult to measure.



### Cockroach Control Method Definitions

**Bait Station Placement**—Careful placement of tamper-proof bait stations in areas inaccessible to children and pets and near existing cockroach infestations.

**Band/Perimeter**—Coarse spray of liquid insecticide in a wide band or strip.

**Broadcast**—Coarse spray of liquid insecticide or application of a dust insecticide over a large area; should be evenly distributed.

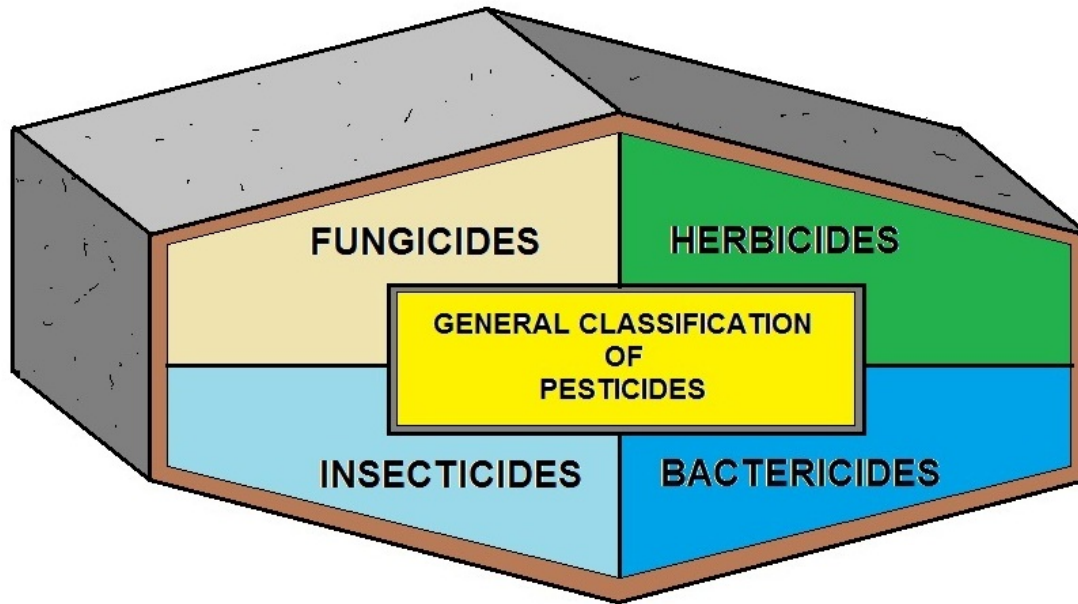
**Crack and Crevice Aerosol**—Insecticide application of a specialty aerosol using the application tube provided to place insecticides into voids, cavities, cracks and crevices or other small, tight areas.

**Crack and Crevice**—Placement of the insecticide into cracks, crevices, or seams. Applications must be made so no insecticide residue is found outside the crack, crevice, or seam.

**Dusting**—Thin coat of dust formulation not more than one particle thick. Several inches (centimeters) wide. Usually around perimeter of a structure.

**Spot**—Application of an insecticide to a small area, usually a gel bait.





## PESTICIDE CLASSIFICATION

### Pesticide Classification Types

There are several classifications of pesticide types. Pesticides can be classified from chemical standpoint and production method. There are also biological pesticide types. Pesticides are often classified according to the type of pest they control. There are also particular pesticide types.

#### Chemical Based Pesticide Types

- Organophosphate pesticides attack the nervous system of pests and disrupt the enzyme that regulates acetylcholine action.
- Carbamate pesticides also disrupt the regulation of acetylcholine metabolism.
- Organochlorine pesticides were frequently used in the past, but many of them have been banned because of their negative effects on health and environment.
- Pyrethroid pesticides are synthetic kinds of the natural pyrethrin and produce toxic effect on the nervous system.

#### Biological Pesticide Types

Biological pesticide types come from natural sources such as plants, bacteria, animals, and some minerals.

- Microbial pesticides comprise bacteria, viruses, fungi, and protozoans that kill, suppress, or compete with pests.
- Biochemical pesticides such as pheromones and plant extracts are of natural origin and control pests by nontoxic mechanisms.
- Plant incorporated protectants are produced by plants from genetic materials previously introduced to the plant.

#### Pesticide Deaths from Exposure

The World Health Organization reports that every year over 200,000 people are killed due to pesticide toxicity all over the world. Incredibly, pesticides are responsible for about 3,000,000 poisonings yearly.

## **Pesticide Resistance**

The common use of many pesticides may contribute to the development of resistance among the target pests. Extensive herbicide and pesticide use resulted in genetic modifications in some pests with resistance to pesticide compounds. The use of the same pesticides/herbicides in some areas for many years led to the development of immunity to the herbicides among targeted plant and insect species. Resistance makes pest control considerably difficult.

## **The Effects on the Environment**

Scientists cannot determine exactly what will happen to a particular pesticide once it enters the environment. They gather information which is used to make informed decisions about pesticide use and possible risks resulting from that particular use. **PLEASE REMEMBER** Pesticides are made to be toxic. Be an informed consumer and use environmental common sense when using pesticides in your home and garden. These chemicals may affect your health, the health of your neighbors and the health of smaller animals and plants in your community.

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

Pesticides which are sprayed move through the air and eventually end up in other parts of the environment, such as soil or water. Pesticides applied directly to the soil may be washed off the soil into nearby bodies of surface water, may evaporate into the air, or may percolate through the soil to lower soil layers and groundwater.

Pesticides may enter surface waters when applied for weed control, or indirectly as a result of leaching from boat paint, runoff from soil or other routes.

### ***Properties of Pesticides***

- The properties of pesticides determine their fate and behavior in the environment. The important properties are persistence, volatility, and solubility in water.
- When pesticides are released into the environment, they are either: 1) broken down, or degraded, by the action of sunlight, water or other chemicals, or microorganisms, such as bacteria; or 2) resist degradation and thus remain unchanged in the environment for long periods of time. The persistence of a pesticide is its ability to remain unchanged. Persistence is measured by half-life. The half-life is the time it takes for half of the initial amount of a pesticide to break down. Thus, if a pesticide's half-life is 30 days, half will be left after 30 days, one-quarter after 60 days, and one-eighth after 90 days and so on.
- When the pesticide is broken down, this usually leads to the formation of less harmful products. However, in some instances the products can be more toxic than the original pesticide. Pesticides that are easily broken down generally move the shortest distance and have the least adverse effects on people or other organisms. Persistent pesticides generally move the longest distances and have the greatest potential to accumulate in living organisms.

- The volatility of a pesticide is its ability to evaporate. Pesticides that are more volatile have the greatest potential to go into the atmosphere. If they are persistent, they can move long distances.
- The solubility of a pesticide is its ability to dissolve. If a pesticide is very soluble in water, it is more easily transported by rainwater as runoff, or through the soil as a potential groundwater contaminant. Water soluble pesticides are more likely to remain in the surface water where they may adversely affect fish and other organisms.

## Properties of the Environment

The individual properties of soil, water and living organisms affect the fate and behavior of pesticides. Climate and topography also play a role. Soils vary in their ratios of sand, organic matter, metal content, acidity, porosity, permeability, etc. These soil characteristics influence the behavior of pesticides. Water characteristics also vary and influence pesticide behavior. Some of the characteristics are acidity, depth, temperature, clarity, flow rate, presence of biological organisms and general chemistry.

Living organisms accumulate certain pesticides. Through the process of bioaccumulation, pesticides accumulate in lower organisms and are passed to higher organisms in the food chain when eaten. The higher organism will accumulate the pesticides at higher levels than their food source. Pesticide levels in fish, for example, can be tens to hundreds of thousands of times greater than ambient water levels in which they live.

Humans are at the top of the food chain. They bioaccumulate the pesticides accumulated by the lower animals and plants that they eat. It is not only fish but also domestic farm animals and plant food which can accumulate pesticides. Care must be used in the use of pesticides in agricultural as well as home and garden scenarios.

### Health Concerns

Pesticides are designed to kill living organisms and the EPA prohibits claims that these chemicals are safe or nontoxic. Studies on animals have shown that of the 34 chemicals encompassing 95% of lawn pesticides, 10 are carcinogens, 12 cause birth defects, 20 are neurotoxic, seven alter the reproductive process, 13 cause liver and kidney damage, and 29 are sensitizers or irritants.

A study of indoor air quality by the EPA in 1990 detected 26 pesticides. In animals, 19 of these pesticides are nerve poisons, 18 may cause cancer, 15 are mutagens, 15 could cause birth defects, and 19 can cause reproductive problems. DEET, the active ingredient in many insect repellants, is responsible for more than 5,000 poisonings every year in the U.S. (National Capitol Poison Center, Georgetown University Hospital, Washington, D.C.). DEET can cause central nervous system disturbances, dermatitis, and skin irritation.

At the EPA's current rate of testing, it will take more than a decade before 32 of the 34 most commonly used lawn chemicals can be fully tested for their effects on human health. Inactive or inert ingredients are another problem with pesticides. Inert ingredients are designed to preserve the active ingredients, make them easier to apply or improve their killing ability. Information on inert ingredients is not required to be put on a product's label because this information is considered proprietary. These ingredients typically comprise between 80 - 90% of a pesticide, and in some cases are more toxic than the active ingredients.

Children and individuals with impaired immune systems are more vulnerable than adults to pesticide poisoning. Children have higher metabolic rates, and absorb higher concentrations of toxins from the environment than adults. In addition, children have not fully developed their bodies' defense systems against toxins. Their livers and kidneys, the organs that detoxify and excrete foreign substances, and act as barriers to absorption of toxic substances, have not fully developed.

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

### **Evaluating Pesticides EPA**

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

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

In evaluating pesticides for reregistration, EPA obtains and reviews a complete set of studies from pesticide producers, describing the human health and environmental effects of each pesticide.

The Agency develops any mitigation measures or regulatory controls needed to effectively reduce each pesticide's risks. EPA then reregisters pesticides that can be used without posing unreasonable risks to human health or the environment. When a pesticide is eligible for reregistration, EPA explains the basis for its decision in a Reregistration Eligibility Decision (RED) document.

## Classes of Insecticides

The classification of insecticides is done in several different ways:

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

## 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.

## Categories of Agricultural Adjuvants

### Activators

Spreaders

*wetters*

Stickers

*builders*

*extenders*

Emulsifiers

*dispersants*

*suspending agents*

Plant Penetrants

*translocators*

Emulsifiable oils

*activators*

### Special Purpose

Foliar nutrients

Compatibility agents

Drift retardants

Foam retardants

Buffers

Inverting agents

Soil penetrants

Stabilizing agents (UV filters)

Feeding stimulants

Washing agents

Sinking agents

Protectant binders

## Adjuvants - Primary Types

A pesticide adjuvant is broadly defined as any substance added to the spray tank, separate from the pesticide formulation that will improve the performance of the pesticide.

**Diluent:** A substance used to dilute something.

**Fillers:** A diluent in Powder form.

**Spreaders:** A substance that is added to assist even distribution over the target.

**Surfactants:** Chemicals that physically alter the surface tension of a spray droplet.

**Wetting Agent:** A chemical added that can be added to a liquid to reduce its surface tension and make the chemical more effective in spreading over and penetrating surfaces.

## Applicators Must Think About These Concerns:

- Where will the pesticide go after it leaves its container or application equipment?
- What effects could it have on those non-target sites it may reach?
- What can I do to minimize harmful effects?

## **Pesticide Primary Characteristics**

### **Solubility**

Is a measure of the ability of a pesticide to dissolve in a solvent, usually water. Highly soluble pesticides dissolve easily in water. They are more likely to move with surface water in runoff or by leaching down through the soil than less soluble pesticides.

### **Adsorption**

Measure how well a pesticide sticks to soil particles. It occurs because of the attraction between the chemical and soil particles. Typically, oil-soluble pesticides are more attracted to clay particles and organic matter in soil than water-soluble pesticides. Also, pesticide molecules with a positive (+) charge are tightly adsorbed to negatively (-) charged soil particles. A pesticide that adsorbs to soil particles is less likely to move from the spray site than one that does not adsorb tightly to soil.

### **Persistence**

Is the ability of a pesticide to remain present and active in its original form for a long time before breaking down. Persistence is described in terms of half-life: the time needed for 50% of the chemical to break down (degrade). The longer the half-life, the more persistent the pesticide.

### **Residue**

The amount of pesticide that remains in the environment after an application or a spill. A residue is desirable when it provides long-term pest control and reduces the need for repeated applications. However, some persistent pesticides can harm sensitive plants or animals, including humans. Therefore, it is especially important to prevent persistent pesticides from moving offsite through improper handling, application, drift, leaching, or runoff.

### **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 weight.

## **Wettable Powders (WP or W)**

Wettable powders are dry, finely ground formulations that look like dusts. They usually must be mixed with water for application as a spray. A few products, however, may be applied either as a dust or as a wettable powder; the choice is left to the applicator. Wettable powders contain 5%–95% active ingredient by weight, usually 50% or more. The particles do not dissolve in water. They settle out quickly unless constantly agitated to keep them suspended.

## **Water-Dispersible Granules (WDG) or Dry Flowables (DF)**

Water-dispersible granules, also known as dry flowables, are like wettable powders except instead of being dustlike, they are formulated as small, easily measured granules. Water-dispersible granules must be mixed with water to be applied. Once in water, the granules break apart into fine particles similar to wettable powders. The formulation requires constant agitation to keep them suspended in water. The percentage of active ingredient is high, often as much as 90 percent by weight.

## **Soluble Powders (SP or WSP)**

Soluble powder formulations look like wettable powders. However, when mixed with water, soluble powders dissolve readily and form a true solution. After they are mixed thoroughly, no additional agitation is necessary. The amount of active ingredient in soluble powders ranges from 15% to 95% by weight; it usually is more than 50%. Soluble powders have all the advantages of wettable powders and none of the disadvantages except the inhalation hazard during mixing. Few pesticides are available in this formulation because few active ingredients are readily soluble in water.

## **Water-Soluble Packets (WSB or WSP)**

Water-soluble packets reduce the mixing and handling hazards of some highly toxic pesticides. Manufacturers package precise amounts of wettable powder or soluble powder formulations in a special type of plastic bag. When you drop these bags into a filled spray tank, they dissolve and release their contents to mix with the water.



## **Pesticides are Broken Down or Degraded by:**

1. **Chemical degradation** usually involves a chemical reaction with water; it does not involve living organisms.
2. **Microbial action** is the breakdown of chemicals by soil microorganisms, such as fungi or bacteria.
3. **Photodegradation** is the breakdown of chemicals in reaction to sunlight.
4. **Volatility** is the tendency of a pesticide to turn into a gas or vapor. Some are more volatile than others. The chance of volatilization increases as temperatures and wind increase. Also, volatility is more likely under conditions of low relative humidity because evaporation increases in drier conditions.

## **Pesticide Formulation Breakdown**

1. The pesticide active ingredient that controls the target pest
2. The **carrier**, such as an organic solvent or mineral clay
3. **Adjuvants**, such as stickers and spreaders

Other ingredients, such as stabilizers, safeners, dyes, and chemicals that improve or enhance pesticidal activity

## **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.

## Comparison of Roach Control Pesticide Active Ingredients

Type of Active Ingredient	Representative Chemicals*	Hazards	Formulation
<i>*For groups of active ingredients of the same type.</i>			
Avermectin		High acute toxicity in pure form, but the concentrations used in ant baits (less than 0.01%) have low acute toxicity. Toxic to the nervous system and to the developing fetus at very low doses. Not absorbed through the skin to any great extent. Highly toxic to fish and aquatic invertebrates.	Gel, Dust, Aerosol, Solution, Granular, Impregnated materials
Borates	Borax Boric acid Sodium metaborate	Low acute toxicity. Not absorbed through the skin; however, ingestion of small amounts of boric acid every day over several months has been shown to reduce sperm counts in laboratory animals. Toxic to plants.	Gel, Solution, Paste, Dust, Aerosol, Granular
Diatomaceous Earth	Crystalline silica	Causes lung irritation when inhaled. Long-term exposure to diatomaceous earth dust is associated with lung cancer in occupational settings.	Dust

Type of Active Ingredient	Representative Chemicals*	Hazards	Formulation
Fipronil		Moderately acutely toxic by ingestion, but not absorbed substantially through the skin. Toxic to the nervous system. Classified as a Possible carcinogen by US EPA. High toxicity to aquatic life and to birds.	Gel, Pelleted, Powder, Solutions, Granular, Impregnated materials
Hydramethylnon		Low acute toxicity to humans. Not extensively absorbed through the skin. Toxic to the developing fetus and interferes with reproduction at moderate doses. High toxicity to aquatic life.	Gel, Pelleted, Solution, Granular
Indoxacarb		Has moderate to low acute and chronic oral toxicity to humans. High toxicity to aquatic life.	Solution, Granular, Gel, Impregnated materials
Insect Growth Regulators	Hydroprene Methoprene Pyriproxifen	Very low acute and longer-term toxicity to humans. High toxicity to aquatic invertebrates. Most products with IGRs also contain an insecticide, usually a pyrethroid.	Aerosol, Solution, Impregnated materials
Neonicotinoids	Acetamiprid Clothianidin Imidacloprid Thiamethoxam	Moderate acute toxicity to humans and absorbed through the skin to some extent. Toxic	Gel, Granular, Solution, Aerosol, Impregnated materials

Type of Active Ingredient	Representative Chemicals*	Hazards	Formulation
Pyrethroids	Allethrin Bioallethrin Cyfluthrin Cyhalothrin Cypermethrin Deltamethrin Esfenvalerate Permethrin Tetramethrin Tralomethrin	<p>to the nervous system. Imidacloprid has been shown to reduce sperm counts in laboratory animals with long-term exposure. Highly toxic to aquatic invertebrates and bees.</p> <p>Moderate acute ingestion and inhalation toxicity. Sensitizer, causing allergic reactions and asthma in some people. Toxic to the nervous system. Highly toxic to aquatic invertebrates and bees. Most products containing pyrethroids also contain a synergist that increases the insecticidal activity of the pyrethroid. Typical synergists include piperonyl butoxide (PBO) and N-octyl bicycloheptene dicarboximide. US EPA considers both of these synergists Possible carcinogens.</p>	Solution, Granular, Aerosol
Organophosphates	Acephate Chlorpyrifos, DDVP Malathion Naled Propetamphos	High acute toxicity to humans at low concentrations. Toxic to the nervous system, especially for	Aerosol, Solution, Granular, Impregnated materials

Type of Active Ingredient	Representative Chemicals*	Hazards	Formulation
		children. Highly toxic to aquatic life.	
N-Methyl carbamates	Carbaryl Propoxur	High acute toxicity to humans at low concentrations. Toxic to the nervous system, especially for children. Highly toxic to aquatic life.	Aerosol, Granular, Solution, Impregnated materials

## Common Cockroach Pesticide Chemicals/Treatments Detailed

Insecticides are generally available as sprays (in liquid or wettable powder form), dusts, baits, and aerosol (pressurized) sprayers. Dusts are preferred because they will disperse deeply into cracks, walls, voids and other inaccessible areas that are not treatable with other formulations. Dusts and baits are most adversely affected by damp conditions.

Pyrethrum (sometimes called pyrethrin) insecticide is made from a specific chrysanthemum flower. It is used most often as spray applications. It has little residual effect, so is effective only in flushing insects out of hiding or as a contact spray. This insecticide is a common house or garden aerosol spray. Look on the active ingredient list on package labels.

Resmethrin is a synthetic pyrethrin. It is a good contact insecticide and provides good residual effect. Though available as a spray, it is found primarily as an aerosol, as in house or garden insecticides.

Common names (the names found on the list of active ingredients) of other effective pesticides include: propoxur (Baygon), cyfluthrin, permethrin, deltamethrin, and tetramethrin. A variety of formulations may be available, including sprays (liquid or wettable powders), aerosol sprays, baits or dust. No single chemical or formulation will control all cockroaches. Some German cockroach infestations are resistant to one or more insecticides. Apply insecticides only to cracks, crevices, or unexposed surfaces, and not beyond the point of runoff. Avoid spraying carpets, wallpapers, or other furnishings that might be stained.

### Biological Insecticides

Recent efforts to reduce broad spectrum toxins added to the environment have brought biological insecticides back into vogue.

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

### Borates

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

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

Unlike most other wood preservatives and organic insecticides that penetrate best in dry wood, borates are diffusible chemicals—they penetrate unseasoned wood by diffusion, a natural process.

Wood moisture content and method and length of storage are the primary factors affecting penetration by diffusion. Properly done, diffusion treatments permit deep penetration of large timbers and refractory (difficult-to-treat) wood species that cannot be treated well by pressure. The diffusible property of borates can be manipulated in many ways; suitable application methods range from complex automated industrial processes to simple brush or injection treatments.

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

## **Carbamates**

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

## **Deltamethrin (Delta Dust or Drione Dust)**

Deltamethrin is an insecticide belonging to the pyrethroid family. Pyrethroids are the man-made versions of pyrethrins, natural insecticides from chrysanthemum flowers. Deltamethrin is used outdoors on lawns, ornamental gardens, golf courses, and indoors as a spot or crack and crevice treatment. In its purest form, deltamethrin is colorless or white to light beige crystals that have no odor.

Deltamethrin is in a variety of products used to kill a wide range of insects. Deltamethrin can be formulated in insecticide products as aerosols, sprays, dusts, granules and wettable powders. The illegal, unregistered product known as “Chinese Chalk” or “Miraculous Chalk” often contains deltamethrin as the active ingredient. “Chinese Chalk”, “Miraculous Chalk”, and products like them are not registered for use in the United States and illegal products such as these should be avoided at all times.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.



### **How does Deltamethrin work?**

Deltamethrin can kill insects by direct contact or if they eat it. It disrupts their normal nervous system function. It is less toxic to mammals due to their higher body temperature, larger body size, and decreased sensitivity to the chemical.

### **How might I be exposed to Deltamethrin?**

You can be exposed to deltamethrin if you touch, eat, or breathe it in. As an example, it could be breathed in if a fine mist or dust containing deltamethrin gets in the air you breathe. Exposure to deltamethrin can be limited by reading and following label directions.

## **Demeton**

Demeton is a phosphorothioate insecticide with the chemical formula C<sub>8</sub>H<sub>19</sub>O<sub>3</sub>PS<sub>2</sub>.

## **Demeton-S-methyl**

Demeton-S-methyl is an organic compound with the molecular formula C<sub>6</sub>H<sub>15</sub>O<sub>3</sub>PS<sub>2</sub>. It is used as an acaricide and insecticide; more specifically it is an organothiophosphate acaricide and an aliphatic organothiophosphate insecticide, respectively. It is flammable.

## **Diazinon**

Diazinon (IUPAC name: O,O-Diethyl O-[4-methyl-6-(propan-2-yl)pyrimidin-2-yl]phosphorothioate), a colorless to dark brown liquid, is a thiophosphoric acid ester developed in 1952 by Ciba-Geigy, a Swiss chemical company (later Novartis and then Syngenta). It is a non-systemic organophosphate insecticide formerly used to control cockroaches, silverfish, ants, and fleas in residential, non-food buildings. Diazinon was heavily used during the 1970s and early 1980s for general-purpose gardening use and indoor pest control. A bait form was used to control scavenger wasps in the western U.S. Residential uses of diazinon were outlawed in the U.S. in 2004 but it is still approved for agricultural uses.

Diazinon kills insects by inhibiting acetylcholinesterase, an enzyme necessary for proper nervous system function. Diazinon has a low persistence in soil. The half-life is 2 to 6 weeks. The symptoms associated with diazinon poisoning in humans include weakness, headaches, tightness in the chest, blurred vision, nonreactive pinpoint pupils, excessive salivation, sweating, nausea, vomiting, diarrhea, abdominal cramps, and slurred speech.

In 1988, the Environmental Protection Agency prohibited the use of Diazinon on golf courses and sod farms because of decimation of bird flocks that congregated in these areas. In the United States as of December 31, 2004, it became unlawful to sell outdoor, non-agricultural products containing diazinon. It is still legal for consumers to use diazinon products purchased before this date, provided that they follow all label directions and precautions

## **Dicrotophos**

Dicrotophos is an organophosphate acetylcholinesterase inhibitor used as an insecticide. Some common brand names for dicrotophos include Bidrin, Carbicron, Diapadrin, Dicron and Ektafos.

## **Dimethoate**

Dimethoate is a widely used organophosphate insecticide used to kill insects on contact. It was patented and introduced in the 1950s by American Cyanamid. Like other organophosphates, dimethoate is an anticholinesterase which disables cholinesterase, an enzyme essential for central nervous system function.

## **Fipronil**

Fipronil is a broad use insecticide that belongs to the phenylpyrazole chemical family. Fipronil is used to control ants, beetles, cockroaches, fleas, ticks, termites, mole crickets, thrips, rootworms, weevils, and other insects. Fipronil is a white powder with a moldy odor. Fipronil was first registered for use in the United States in 1996. Fipronil is used in a wide variety of pesticide products, including granular products for grass, gel baits, spot-on pet care products, liquid termite control products, and products for agriculture. There are more than 50 registered products that contain fipronil.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378. Fipronil kills insects when they eat it or come in contact with it. Fipronil works by disrupting the normal function of the central nervous system in insects. Fipronil is more toxic to insects than people and pets because it is more likely to bind to insect nerve endings.

Health effects from a brief exposure to fipronil depend on how someone is exposed to the chemical. Direct, short-term contact with skin can result in slight skin irritation. When individuals have eaten fipronil, reported health effects included sweating, nausea, vomiting, headache, stomach pain, dizziness, weakness, and seizures. Signs and symptoms from a brief exposure to fipronil generally improve and clear up without treatment. In the soil, naturally occurring organisms break down fipronil into smaller chemicals, and on the soil surface, fipronil is broken down by sunlight.

Fipronil breaks down in the soil so that half of the original amount is gone in about 125 days. This breakdown time is called the “half-life” of the pesticide. Fipronil sticks tightly to soil and does not mix very well with water. Therefore, it does not move much in the soil and is not expected to get into groundwater. Fipronil reacts with water to break down into smaller chemicals at a speed that increases as the water becomes less acidic. When fipronil in the water is exposed to sunlight it breaks down rapidly with a half-life of 4-12 hours. Fipronil and its breakdown products can build up in water under normal conditions.

## **Hydramethylnon**

Hydramethylnon is an organic chemical compound. It is also known as AC 217,300. It is in a chemical class called trifluoromethyl aminohydrazone, which is a metabolic inhibitor. It is used primarily as an insecticide in the form of baits for cockroaches and ants. Some brands of insecticides that include hydramethylnon are Amdro, Combat, Blatex, Cyaforce, Cyclon, Faslane, Grant's, Impact, Matox, Maxforce, Pyramidron, Siege, and Wipeout.

Hydramethylnon is a yellow to orange solid. It is stable under normal temperatures and pressures, but may pose a slight fire hazard if exposed to heat or flame. It may burn, but does not ignite readily.

It poses a fire and explosion hazard in the presence of strong oxidizers. Thermal decomposition of hydramethylnon may release highly toxic fumes of fluorides and oxides of nitrogen and carbon.

## **Imidacloprid**

Imidacloprid is a nicotine-based, systemic insecticide, which acts as a neurotoxin and belongs to a class of chemicals called the neonicotinoids. Although it is now off patent, the primary manufacturer of this chemical is Bayer CropScience, (part of Bayer AG). It is sold under the trade names Kohinor, Admire, Advantage (Advocate) (flea killer for pets), Gaucho, Mallet, Merit, Nuprid, Prothor, Turfthor, Confidor, Conguard, Hachikusan, Premise, Prothor, Provado, and Winner. Imidacloprid is one of the most widely used insecticides and can be applied by soil injection, tree injection, application to the skin, or broadcast foliar or ground application as a granular or liquid formulation or as a pesticide-coated seed treatment.

In France, beekeepers reported a significant loss of honeybees in the 1990s, which they attributed to the use of imidacloprid (Gaucho). See Imidacloprid effects on bee population. In response to this loss of bees called "mad bee disease," the French Minister of Agriculture convened a panel of expert scientists (Comite Scientifique et Technique) to examine the impact of imidacloprid on bees.

After reviewing dozens of laboratory and field studies conducted by Bayer CropScience and by independent scientists, the panel concluded that there was a significant risk to bees from exposure to imidacloprid on sunflowers and maize (corn), the only crops for which they had exposure data. Following the release of this report, the French Agricultural Ministry suspended the use of imidacloprid on maize and sunflowers. Italy, Germany, and Slovenia have also suspended certain uses of the neonicotinoids based on concerns for bees

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

## **Indoxacarb**

Indoxacarb is an oxadiazine pesticide developed by DuPont that acts against lepidopteran larvae. It is marketed under the names Indoxacarb Technical Insecticide, Steward Insecticide and Avaunt Insecticide. It is also used as the active ingredient in DuPont's line of commercial pesticides: Advion and Arilon. The insecticide belongs to the oxadiazine chemical family and is being registered for the control of lepidopterous pests in the larval stages. Insecticidal activity occurs via blockage of the sodium channels in the insect nervous system and the mode of entry is via the stomach and contact routes.

## **Neonicotinoids**

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

## **Organochlorine Compounds**

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

## **Organophosphates**

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

### **Organophosphate Dangers**

Organophosphate pesticides are chemically composed of esters of phosphoric acid. Organophosphate pesticides are powerful poisons and kill the pests by means of acetylcholinesterase blockage. This results in nervous and respiratory injuries leading to killing of insects. However, organophosphate insecticides are also dangerous for humans.

### **Common Organophosphates Pesticides**

One of the main pesticide related products used in pest control are Malathion, methyl parathion, fenitrothion, diazinon, chlorpyrifos, tetrachlorvinphos, dichlorvos, phosmet, and azinphos methyl. Organophosphate pesticides are applied as contact and systemic insecticides in agriculture pest control.

### **Organophosphate Delayed Poisoning Effects**

Pesticide related applicator exposure may lead to cumulative intoxication with unfavorable effects on the nervous system. Researchers find psychological and behavioral changes in humans after the exposure to the organophosphate insecticides.

### **Organophosphate Related Diseases**

Organophosphate insecticides are associated with common diseases like short-sightedness and Saku disease. Saku disease is characterized by the optic neuropathy and visual disturbances such as myopia, astigmatism, reduced vision, narrowing of the visual fields, degeneration of ciliary muscle and retina.

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NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

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

## **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.

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

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

Releases to the environment are decreasing as a result of declining consumption and changing use methods. However, PCP is still released to surface waters from the atmosphere by wet deposition, from soil by run off and leaching, and from manufacturing and processing facilities.

PCP is released directly into the atmosphere via volatilization from treated wood products and during production. Finally, releases to the soil can be by leaching from treated wood products, atmospheric deposition in precipitation (such as rain and snow), spills at industrial facilities and at hazardous waste sites.

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

## **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.

## **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.

## **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.

## **Pyrethroids**

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

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

Systemic toxicity by inhalation and dermal absorption are low, however—there have been very few systemic poisonings of humans by pyrethroids. Though limited absorption may account for the low toxicity of some pyrethroids, rapid biodegradation by mammalian liver enzymes (ester hydrolysis and oxidation) is probably the major factor responsible. This course contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used.

Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

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

### **About These Pesticides**

Pyrethrins and pyrethroids are insecticides included in over 3,500 registered products, many of which are used widely in and around households, including on pets, in mosquito control, and in agriculture.



The use of pyrethrins and pyrethroids has increased during the past decade with the declining use of organophosphate pesticides, which are more acutely toxic to birds and mammals than the pyrethroids. This change to less acutely toxic pesticides, while generally beneficial, has introduced certain new issues. For example, residential uses of pyrethrins and pyrethroids may result in urban runoff, potentially exposing aquatic life to harmful levels in water and sediment.

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

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

Most pyrethrins and some pyrethroid products are formulated with synergists, such as piperonyl butoxide and MGK-264, to enhance the pesticidal properties of the product. These synergists have no pesticidal effects of their own but enhance the effectiveness of other chemicals.

\* Pyrethrins, a single pesticide active ingredient, contain six components that have insecticidal activity:

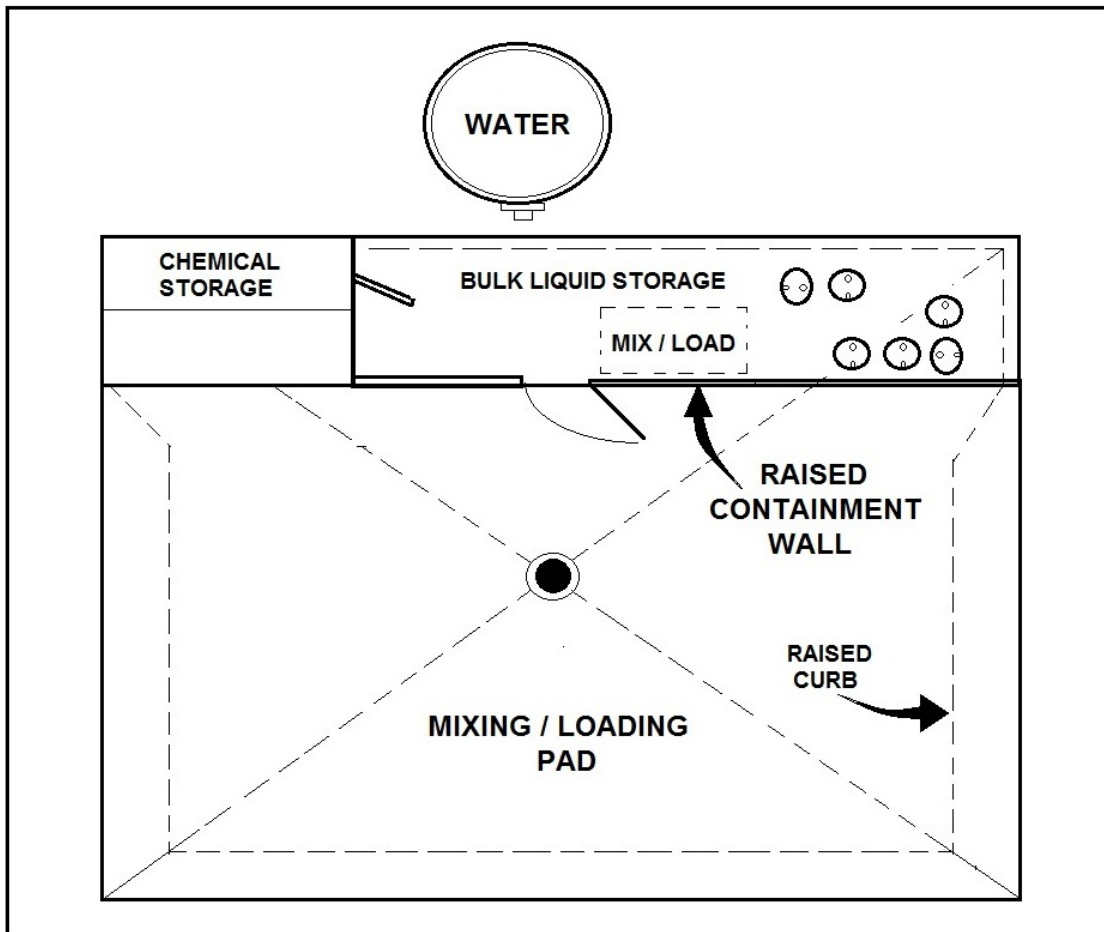
pyrethrin 1, pyrethrin 2, cinerin 1, cinerin 2, jasmolin 1, and jasmolin 2

**Pyrethroids include:**

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

**Synergists include:**

MGK-264 and Piperonyl butoxide



**PESTICIDE STORING AND MIXING AREA DIAGRAM**

### **Pesticide Poisoning**

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

### **Seeking Medical Attention 1-800-222-1222**

If you are having symptoms but are unsure if they are pesticide related, at least notify someone in case your symptoms become worse. But 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.

## Insect Growth Regulators Summary

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

### Trapping

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

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

### Roach Traps

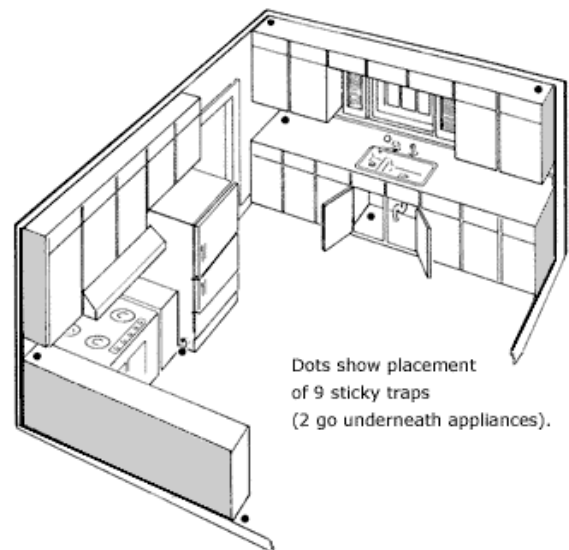
Regardless of the treatment method you choose, another tool which can be a great help when treating roach infestations is the use of Roach Traps. These rely on roach pheromones to attract all types of roaches but they work particularly well for German and several of the large roach species. Place them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

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

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

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

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



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

Whatever form of pest control management plan you choose to implement, try to follow these guidelines and the label. Knowledge is essential and with it comes an understanding of why roaches are so hard to control. As difficult as it may seem, you can gain control with patience and persistence. Once control is acquired, preventative maintenance will stop future infestations. In the United States, we have the very best equipment, product, chemicals, treatments the world has to offer for pest control. And we have you, a highly trained professional pesticide applicator.



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

## More on Insect Growth Regulators

Insect Growth Regulators (IGRs) are a group of compounds which disrupt the normal growth and development of insects. The IGRs are considered reduced-risk tools. They generally have very low toxicity to mammals because they act by disrupting the hormonal processes that are specific to insects.

IGRs that mimic the juvenile hormones of insects are called juvenile hormone analogues (JHAs). JHAs are chemical compounds whose structural chemistry is very similar to the hormones that the immature cockroach produces naturally. JHAs interfere with the proper development of last instar cockroach nymphs. Instead of the nymphs molting into reproductive adults they molt into "adultoids", which often have twisted wings and are sterile. Because the adultoids are unable to reproduce, over time, the cockroach populations begin to decline. JHAs are an effective method of long term German cockroach control. However, because JHAs eliminate reproduction but do not kill existing cockroaches they are very slow acting (from four to nine months to achieve control). JHAs are often combined with residual insecticides. In this manner most of the population can be eliminated quickly by the insecticide, cockroaches that survive the insecticide treatment are then sterilized by the JHA.

Insect Growth Regulators are available in spray formulations or point source dispensers (where the IGR is released on a filter paper contained in a permeable plastic station then transmigrates throughout the infested area).

### **Chitin Synthesis Inhibitors (CSI)**

Chitin synthesis inhibitors (CSI) are another type of insect growth regulator that is being developed for use in management programs targeting a variety of insect pests. Exposure CSIs results in the abnormal molting of nymphs causing them to die during the molting process. CSIs also cause adult cockroaches to form abnormal egg cases and interferes with the hatching process.

### **Chitin Synthesis Inhibitors on Cockroaches**

Insect growth regulators (IGRs) are pesticides that don't usually kill insects outright but instead affect the ability of insects to grow and mature normally. IGRs either block the insect's ability to turn into an adult or cause it to change into an adult before it is physically able to reproduce. If immature insects are not able to molt into reproductive adults, the population will eventually die out. Some call IGRs "birth control" for insects.

Some IGRs are juvenoids, man-made chemical mimics of the juvenile growth hormones that occur in an insect's body. Natural hormones control how long an insect remains in each larval or nymphal stage and when it turns into a reproductive adult.

Cockroach nymphs that have been exposed to juvenoid IGRs either never molt into adults or they develop into sterile adults that cannot reproduce. Cockroach adults that were exposed to IGRs as nymphs develop short, twisted wings and a darker body color. IGRs also can affect insects that are exposed later, in the adult stage, by blocking the development of viable eggs. Eggs that are exposed to IGRs may not hatch.

Juvenoid IGRs are slow to show effects and have no knockdown. You are not killing individual insects, just preventing future populations. If you use an IGR alone, it will take months to achieve control. Although no new young will be produced, most of the current crop of nymphs and adults will have to die off naturally before you will see results. That's why a standard insecticide is usually applied along with the IGR so customers can see immediate results.

IGRs are especially useful during "clean-outs" or intensive service. Any missed cockroaches or other insects left after the treatment will be affected by the IGR and will not be able to reproduce. IGRs also can be useful against insects that have shown resistance to standard insecticides since IGRs have a different mode of action.

An added benefit to the use of some IGRs is that they stimulate cockroaches to feed. Using an IGR along with a cockroach bait can result in improved bait acceptance since the roaches are more likely to feed on the bait.

### **IGR Study**

Second- and fifth-instar *Blattella germanica* (L.), fed the chitin synthesis inhibitors triflumuron, chlorfluazuron, hexafluron, and UC 84572 (structure not disclosed) were examined for mortality and developmental abnormalities. All compounds were active against *B. germanica* (L.), with lower diet concentrations being required to kill second instars compared with fifth instars. Chlorfluazuron was significantly more active against second and fifth instars (LC50 = 0.000191 and 0.000363% AI, respectively for the second and fifth instars). UC 84572 also killed nymphs at extremely low concentrations (LC50 = 0.000508 and 0.000754% AI, respectively, for second and fifth instars). LC50's for hexafluron and triflumuron against fifth instars were more than 1,000 times higher than that for chlorfluazuron. Sensitive periods of exposure were determined by comparing effects when four different age classes of fifth instars (1-, 4-, 7-, and 10-d old) fed on the compounds for 3 d. Triflumuron was most effective when ingested during the first three age classes and hexafluron was most effective during the last three age classes. Chlorfluazuron and UC 84572 were most effective when ingested during the second age class (days 4-6). Adults surviving exposure during the fifth instar were often deformed and weak; they died at a greater rate than the controls. However, most surviving adults were able to reproduce normally.

### **Neurotoxins**

Most chemicals used to control insects are neurotoxins which interfere with normal nerve function. Organophosphate insecticides were derived from nerve gases that were first exploited for military purposes. Other insecticides were discovered by testing chemicals to find those that killed pests quickly. About the only thing that kills quickly is a neurotoxin so chemicals that acted on neurotransmissions were sought and developed as insecticides. In the early discovery and development of insecticides, efforts were focused on chemistry rather than biology. Because all animals share basically the same neurochemical systems, neurotoxins are toxic to all animals.

### **Behavior Modifiers**

Behavior-affecting chemicals, such as pheromones, are discovered in the same way as IGRs but tend to be even more specific. Pheromones aid the sexes of a single species to find each other so that effort is not wasted chasing mates of a different species. In a finding that could revolutionize pest control, researchers have discovered the identity of the "perfume" produced by female cockroaches when they are feeling amorous. When the scientists set out traps wafting synthetic versions of the compound, male cockroaches came scurrying within seconds.

There hasn't been a particularly effective way to attract the tenacious pests until now, so pesticide is currently the antroach weapon of choice, according to author Coby Schal of North Carolina State University.

By themselves, cockroach traps probably won't eradicate a whole cockroach population, but they should help with detecting and monitoring the insects, especially in places where even a single bug is too many, such as schools, operating rooms and food processing centers.

Schal also proposed that adding the pheromone to bait laced with insecticide might help reduce cockroach populations via the "domino effect." Cockroaches have about two or three days after eating the poisoned food before they die. In the meantime, they could pass along the insecticide via their feces, which baby cockroaches eat.

Cockroaches are the quintessential chemical communicators. In contrast to the closely related grasshoppers and crickets, which rely on sound and vision as primary modalities in communication, cockroaches use olfactory and tactile signals in their social behavior. Most of the 4000+ described species of cockroaches are nocturnal. Many use long-range volatile pheromones in mate-finding and cuticular contact pheromones in the final recognition process. Short-range volatile pheromones emitted by the male, coupled with nuptial tergal secretions, facilitate proper alignment of the pair prior to copulation. Pheromones also mediate intrasexual conflicts, especially when males establish dominance hierarchies and territories, in parent-offspring communication, stage and population recognition, trail-following behavior, and as epidiectic pheromones that mediate dispersion behavior.

### **Oothecal Parasitoids**

Parasitic wasps are an important natural enemy of cockroaches. The wasps are parasitoids of the cockroach egg case (ootheca) and can have a significant negative impact on outdoor cockroach populations. Most species of parasitoid wasps are associated with peridomestic cockroaches. The majority of these wasps are very tiny (1-5 mm) and do not sting humans. Peridomestic cockroaches like the American and Smokybrown, live in outdoor harborages such as palm trees, tree holes, and woodpiles. The parasitoids live with the cockroaches in the harborage parasitizing their egg cases. When the adult male and female wasps emerge they mate immediately. The female then begins to sting other oothecae laying her eggs inside them. The wasp offspring eat the cockroach embryos inside the ootheca before hatching. This natural system results in 60-70% of all cockroach egg cases being parasitized without any human interference.

Oothecal wasp parasitoids have been tested for potential indoor use. Domestic populations of brown-banded cockroaches were successfully controlled in a California animal rearing facility by these wasps. However, it is doubtful that parasitoid wasps will ever be reared for commercial use. Very few individuals would welcome a population of 200,000 wasps in their home even if they promised to eliminate a severe cockroach infestation.

Note: Wasp parasitoids are extremely susceptible to pyrethroid insecticides. When attempting to eliminate an outdoor cockroach infestation it is important to realize the insecticide applications in peridomestic cockroach harborages may not kill all of the cockroaches but it certainly will eliminate the parasitoids. This can result in future cockroach problems as surviving cockroaches can reproduce unchecked the following year. The application of bait around an infested area is the best way to treat a population of peridomestic cockroaches and preserve the wasp parasitoids.

## **Non-Chemical Control**

Some customers do not want pesticides to be utilized in cockroach management. There are many control strategies available to help solve cockroach problems. Most people who don't see any cockroaches in their homes would probably like to leave it at that and not think too much about spraying or setting out roach bait. But in other settings, it's essential to detect even the smallest sign of the pests.

"The current tools we have for monitoring are basically sticky traps that aren't very efficient. We suggest that this pheromone can be used to detect cockroaches in hospitals, nursing homes and public schools, where you'd first want to determine whether there is an infestation before applying insecticide".

Pheromone-based traps should also be useful in situations where cockroaches are always present to some degree, such as zoos, botanical parks and pet shops. In these cases, groundskeepers are likely to spray only when the infestation reaches a certain level, which they could determine by monitoring the traps.

Vile though it seems to us, the cockroach lifestyle has allowed these organisms to persist through millennia of natural selection. It seems fitting, therefore, that the best tool for combating the pest is not a new invention by humans but something that comes from the cockroach itself.

Cockroach control requires more than just insecticides. You will be most successful if you use a combination of methods. Preventing access to shelter, food, and water around your home is one of the best control measures both outside and inside.

### **Outdoor habitat changes that may help include:**

- ✓ Dispose of garbage in sealed bags and in garbage cans with lids. If you recycle, rinse out cans and bottles, and keep your recycling areas in a dry location away from the house. Do not let your recycling area become too cluttered.
- ✓ If you have pets, do not leave food bowls out overnight and keep kennel areas clean.
- ✓ Keep screens and weather stripping in good repair. Check attic vents and windows. Caulk large openings around outside drainage lines and sewer vents. Steel wool can be used as a temporary filler until you can caulk openings properly.
- ✓ Remember to check grocery bags, boxes, firewood, and other items that may serve as a means of entry for cockroaches.
- ✓ Remove as much mulch or debris around the building as possible. Prune tree limbs and shrubbery so they do not touch the house. Stack wood away from the house and raise the piles off the ground.

### **If cockroaches do get inside, the following tips will help you control them:**

- ✓ Clean up all crumbs and spills on floors, counters, and shelves as soon as they occur.
- ✓ Good sanitation is important, both inside and outside the house. It is often the best control measure for cockroaches.
- ✓ Keep clutter from accumulating, especially in kitchens and bathrooms. Cockroaches often hide in messy cabinets and in stacks of newspapers, bags, and rags.
- ✓ Keep faucets and drains under sinks and appliances in good repair. Do not let water stand in the sink for long periods of time.
- ✓ Keep food and garbage in tight containers.
- ✓ Vacuum often. Vacuuming is very important because it can remove small food crumbs, and cockroach egg-cases that may not be killed by insecticides.



## Glue Board Traps

A variety of glue board traps are available for pest control. They are useful for cockroaches, mice, and other crawling insects. Some traps have special smells that help increase the trapping efficiency. Traps can be placed in cabinets above and under the sink, beside the stove and refrigerator, and in the utility room and bathroom along a wall or in corners. At least six traps should be placed in a home to monitor the cockroaches.



**READ THE LABEL!**

## 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



## Adjuvant Summary

### Activity of Adjuvants

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

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

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

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

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

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

### Proper Handling of Pesticides

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

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

## **Moving Pesticides**

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

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

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

## ***Spill Cleanup and Reporting***

### **What to do when a spill occurs**

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

Streams and wetlands must be protected in the event of an accidental spill of any size. Even diluted chemicals pose a threat to natural habitats when released in large amounts. Extra precautions must be taken when drawing water from streams or ponds. Antisiphoning devices must be used and be in good working order. Tank mixes should be prepared at least  $\frac{1}{4}$  mile from water resources. If this is not possible, make sure the ground at the mixing site does not slope toward the water, or construct an earthen dike to prevent pesticides from flowing into bodies of water or drains.

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

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

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

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

**Decontamination**

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

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

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

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

Pesticides amenable to treatment using lye or lime may be decontaminated when mixed with an excess quantity of either of these materials. Lye or lime can be used in either the dry form or as a 10% solution in water. Caution: caustic soda (lye) can cause severe eye damage to personnel not properly protected. Protect against contact by wearing unventilated goggles, long-sleeved work clothes with coveralls, neoprene gloves, and a chemical-resistant apron. An approved respirator should also be worn. Do not use lye on aluminum surfaces.

## **Bleach**

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

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

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

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

## **Disposal**

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



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

## Cockroach Control Application Method Review

How you control cockroaches and apply insecticides is extremely important. Many people apply insecticide treatments ineffectively because they either choose the wrong product, wrong formulation or wrong application method. Chemicals (insecticides or product) are still widely used and often necessary to get rid of cockroaches.

When choosing an insecticide, you need to consider its effectiveness, convenience, and safety. Remember that although they are effective, you almost always need to use a combination of different methods to reach complete control and you need to follow the label at all times.

For example, many customers use over-the-counter ant and roach aerosols and expect them to provide long-term control. These products are contact insecticides with little residual control. Contact insecticides kill on contact, which means you have to spray the insecticide on the insect for it to work. Another example is when sprays are applied to baseboards rather than to cracks and crevices where cockroaches live. Because most cockroaches don't live behind baseboards, this application will not be very effective. Instead, use a crack and crevice aerosol or a sprayer fitted with a crack and crevice applicator tool to treat areas where cockroaches are hiding.

Which insecticide formulation you choose is very important. Many materials commonly used in home construction can adversely react with certain insecticide formulations, resulting in ineffective control.

For example, emulsifiable concentrate (EC) formulations will usually penetrate into porous materials, making the insecticide unavailable to control cockroaches.

Wettable powder (WP) formulations on the same porous materials will remain active on the surface of the material after the water has dried.

Another example, if you decide to make an application with an EC formulation, you risk damaging some plastic materials.

### **Gel Baits**

Again, these often come in a syringe and customers can easily obtain these from hardware stores. There are several brands available, such as Combat, Maxforce, Avert, and Siege. Apply numerous spots at cockroach hiding places or active areas. Each spot only needs a pea-size amount. In areas where large numbers of roaches exist, a peanut-size amount of gel may be needed at each spot.

### **Bait Stations**

The bait is located in a secure plastic housing or you can apply the bait. It is safer than gel baits since children or pets will not likely contact the bait. The bait is physically harder than gel and is not readily accessible by the roaches compared with the gel bait due to smaller number of placements. Therefore, bait stations may need longer time to kill the roaches. They are also more expensive. Besides the above methods, there are some other methods commonly used by professionals.

### **Dust Baits**

Dust baits are applied as a dust to cracks and crevices, and picked up by roaches through feeding and grooming. Unlike gel bait, they are spread to wider areas and can cause contamination to the environment.

### **Boric Acid Dust**

Dust made of boric acid can be applied behind stoves, refrigerators, and other cockroach hiding places for long-term management. The dust remains effective as long it stays dry. Use boric acid dust sparingly to avoid unnecessary contamination.

### **Inorganic Dusts**

Inorganic dusts, such as silica gel and boric acid, have been used frequently for indoor cockroach control. The dusts are applied with a squeeze-bulb duster into cracks and crevices under sinks, stoves, behind refrigerators, along baseboards, in electrical outlets, cabinets and wall voids. Silica gel is simply finely ground sand or glass that adheres to and absorbs the protective waxes on the cockroach cuticle resulting in cockroach death from dehydration. Boric acid is a stomach poison that is picked up by cockroaches walking across dusted areas. The boric acid adheres to the cockroach cuticle so when the cockroach grooms itself it ingests the boric acid and soon dies.

### **Boric Acid Treatment**

#### **Properties and Advantages**

Boric acid is a wonderful tool for controlling cockroaches in homes, restaurants and other buildings. It is effective in extremely small amounts and retains its potency almost indefinitely provided the deposit remains dry. Unlike many insecticides, boric acid has no repellency to insects and, consequently, roaches return to treated areas repeatedly until they die. Boric acid is deadly to cockroaches, but is low in toxicity to people, pets and other non-target animals. It is also odorless and contains no volatile solvents.

Boric acid is a white, inorganic powder chemically derived from boron and water. Boron is mined from vast mineral deposits in the ground and is used in countless consumer products, including laundry additives, toothpaste and mouthwash. Boric acid insecticide formulations can be purchased at hardware and grocery stores. The powder comes ready-to-use, i.e., no mixing or dilution is required. Formulations sold in plastic, squeeze-type bottles with narrow applicator tips are the easiest to use. (These containers are similar in appearance to the squeezable mustard and ketchup bottles found in restaurants).

Cockroaches succumb to boric acid when they crawl over treated areas. The tiny particles of powder adhere to the cockroaches' body, and the material is ingested as the roach preens the powder from its legs and antennae. Some boric acid is also absorbed through the greasy outer covering of the insect's body. All species of cockroaches are susceptible to boric acid provided the powder is applied into areas where the roaches are living.

#### **Using Boric Acid Like a Pro**

The key to success with boric acid is proper application. For best results, the powder should be applied in a very thin layer barely visible to the naked eye. Piles or heavy accumulations will be avoided by foraging cockroaches much as we would avoid walking through a snow drift. To apply a fine layer, shake the container and puff a small quantity of the powder into the target area.



Manufacturers of boric acid often fill their containers too full of powder -- by using a container which is no more than two-thirds full, an airspace is created at the top which allows the dust to be puffed more easily (A few pennies or pebbles placed inside the container helps prevent the powder from caking). The trick is to give the container a shake, then puff a very light dusting of the powder into the area you wish to treat. Avoid applying a heavy layer, and never apply the material with a spoon.
















Where the powder is applied is just as important as how it's applied. Cockroaches prefer to live in cracks, crevices and secluded areas close to food, moisture and warmth. Kitchens and bathrooms are the most common areas to find cockroaches, although any area of a home may become infested if the infestation is severe, or if species other than the German cockroach are involved. Key areas for treatment include under/behind the refrigerator, stove and dishwasher, into the opening where plumbing pipes enter walls (such as under sinks and behind the commode, shower and washing machine), and into cracks along edges and corners inside cabinets and pantries. Oftentimes, there is a void (hollow space) under kitchen and bathroom cabinets which becomes a hiding place for cockroaches. This area can be accessed and treated by injecting powder through any existing gap at the top of the kickplate, or if none is present, by drilling a few small holes.

NEVER apply boric acid onto countertops or other exposed surfaces, especially those used to prepare food. Any visible residues should be wiped off with a damp cloth. Boric acid can be used alone or in combination with other cockroach control products. An effective way to augment the activity of boric acid is to place containerized cockroach baits such as Combat(R), Raid Max(R) or Roach Ender(R) brands, as discussed earlier. Avoid dusting over, or in the immediate vicinity of your bait stations, as this may reduce the attractancy of the bait. Used correctly, this dual approach will produce results comparable to a professional exterminator.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

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

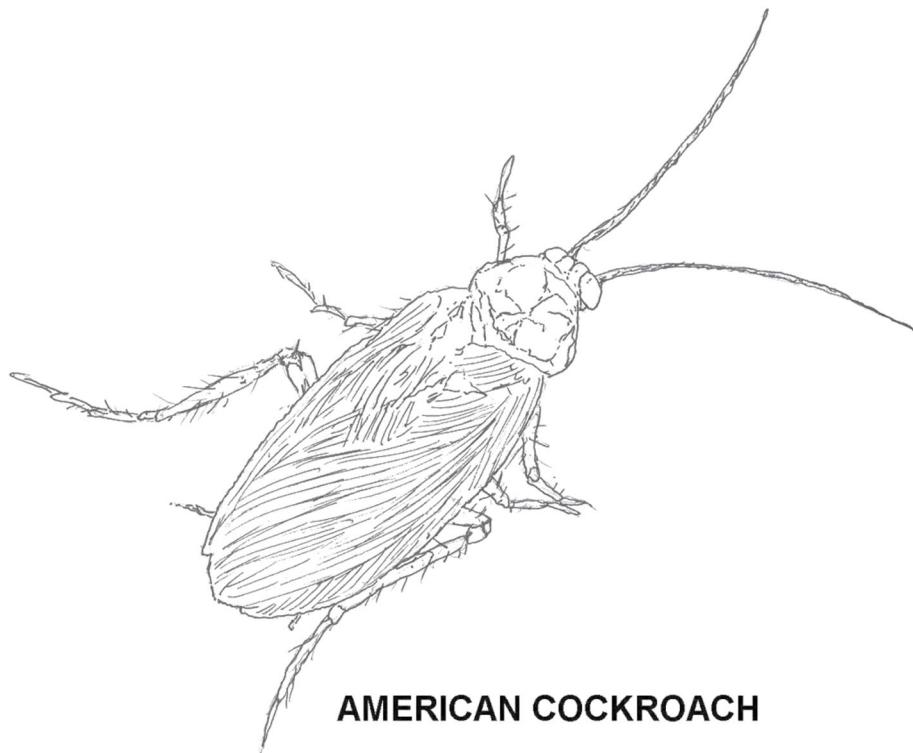
	AMERICAN COCKROACH	ORIENTAL COCKROACH	SMOKEY BROWN COCKROACH	GERMAN COCKROACH	BROWN-BANDED COCKROACH
ADULT					
NYMPH					
EGG					



## COCKROACH IDENTIFICATION

## Cockroach Species Specific Management Review

Because cockroach species have preferred habitats, you will need to target specific areas within your home for most effective control. The following will help guide your control efforts.



**AMERICAN COCKROACH**

### **American Cockroaches (Very Common pest)**

When indoors, the nymphs and adults are usually found in dark, warm and moist areas of basements and crawl spaces, and in and around bathtubs, clothes hampers, floor drains, pipe chases, and sewers.

They are also common around the manholes of sewers, and on the undersides of metal covers over large sump pumps. In the north, this cockroach is often associated with steam heat tunnels. Where steam heat tunnels are not found, the American cockroach is restricted primarily to large institutional buildings. It has also been observed migrating from one building to another during warm months in the north. Occasionally, the cockroaches infest sanitary landfills and can survive winters because of the warmth generated within the piles of trash.

American cockroaches feed on a variety of foods, with an apparent preference for decaying organic matter. The adults can survive two or three months without food but only about a month without water.

- Although American cockroaches are less common than the other species, they can occasionally become a problem inside dwellings. They are found in all locations where German cockroaches are found, and in some areas where oriental cockroaches are found. If signs of American

cockroaches are found, follow the specific treatment recommendations given for German and oriental cockroaches.

- In general, liquid, aerosol, and RTU formulations will degrade quickly under hot, moist conditions. Dust and bait applications, if made properly, will be less affected by heat and moisture and will last longer than liquid formulations.
- Some habitats are especially attractive to American cockroaches and should be specifically investigated. These areas are very warm, moist locations, such as boiler rooms, steam tunnels, heated floor drains, around hot water supply pipes, and heating ducts.

### **Survey**

To control American cockroaches, it is important to do a thorough inspection. A cockroach survey (trapping) is sometimes necessary to determine the extent of an infestation, as even a thorough inspection does not always reveal all cockroach harborages or foraging areas. Cockroach surveys involve placing sticky traps at strategic locations within the building.

Whenever possible place survey traps either against a wall or in a corner of the floor, a shelf, a drawer, or under equipment and counters. Most commercially available traps come complete with bait to encourage cockroaches to enter. One week of trapping with a sufficient number of trapping sites usually provides enough information for effective control.

### **Sanitation, Structural Modifications, and Repairs**

Modifying the interior environment—removing food, moisture, and harborages available to cockroaches—is the first step in treatment. Eliminating cockroach harborages involves caulking in closets and cabinets, caulking under the sink, etc., or making similar structural repairs in the kitchen, bathroom, and other areas of the house.

Cockroaches typically enter homes via boxes, grocery bags, suitcases, furniture, etc. To prevent the insects from establishing a breeding population, clean up all spilled food materials, including crumbs on the floor. Do not leave dirty dishes overnight. Store items such as cereal, crackers, cookies, flour, sugar, and bread in airtight containers.

### **Chemical Control**

Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food.

Baiting can be an effective method to control or eliminate American cockroaches. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.

The use of residual sprays or aerosol foggers within a structure is of little value in controlling American cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy.

## Brownbanded Cockroach Control

Most cockroaches have a flattened oval shape, spiny legs, and grow long, filamentous antennae. Adult brownbanded cockroaches are light brown to glossy dark brown, are about 5/8-inch long and have wings. Males are capable of flight. Nymphs and females are broad when viewed from above, while the male is slender. The male's wings cover the abdomen, whereas the female's wings are short, exposing the abdomen. These roaches have two light yellow or cream transverse bands across the base of the wings and abdomen (twice banded). These bands may appear irregular or broken, but are usually quite apparent on the nymphs and females. Immature stages are smaller, have undeveloped wings and resemble adults. Egg capsules are about 3/16-inch long, crescent or purse-shaped, and yellowish or reddish-brown.

The brownbanded cockroach, *Supella longipalpa*, is not as common as the German cockroach in California and accounts for only about 1% of all indoor infestations. This species seeks out areas that are very warm most of the time, preferring temperatures of about 80°F, about 5° to 10°F warmer than what German cockroaches prefer. Favorite locations include near the warm electrical components of appliances such as radios, televisions, and refrigerators.

- Because brownbanded cockroaches have a lower water requirement than the other cockroach species, they can be found in all rooms of the house, apartment, or building. In addition to all the locations mentioned for German cockroaches, additional locations may need to be treated.
- Check television, stereo, radio, clocks, and other electric motors with warm microclimate areas. Use special caution when attempting treatment because of the possibility of electrical shock. Use freezing treatments where possible, and dust applied very lightly for others. Some of the crack and crevice aerosols may be labeled for use in electrical appliances as well.
- Check trim and framing around windows, doors, and closets. If a treatment is required, use a crack and crevice liquid or aerosol application, or gel bait.
- Examine pictures, tapestries, and other wall decorations carefully. These locations are especially common for brownbanded infestations. If infestations are found, use freezing treatments, gel or tamper-proof baits, or crack and crevice aerosols.
- Furniture with drawers in the bedroom and living room is attractive to the brownbanded cockroach. If infestations or signs are found, treat the interior of furniture using a crack and crevice liquid, aerosol, or RTU insecticide or apply insecticidal baits.
- Hollow locations such as curtain and drapery rods, table legs, and pole lights are important harborages for brownbanded cockroaches as well. Treat these areas similarly as for crack and crevice locations, or carefully apply small amounts of dust. Baits are also especially effective in these locations.
- Other furniture, such as chairs and couches, can also be infested. If found, apply a crack and crevice liquid, aerosol, or RTU treatment to the underside of infested furniture.
- Textured ceilings are a common place for the female brownbanded cockroaches to attach egg cases. Physically remove egg cases, paint the ceiling to discourage cockroaches from returning, and apply a gel bait as a spot treatment if necessary.

## **German Cockroaches (Probably your biggest problem)**

The German cockroach has three developmental stages: egg, nymph, and adult. Females produce a light brown, purse-shaped egg capsule that is less than 1/4-inch-long and contains two rows of eggs. Each capsule contains up to 48 eggs (usually 30 to 48), and adult females usually produce from four to eight egg capsules during their lifetime. At room temperature, one capsule is produced about every 6 weeks. Egg capsules are carried, protruding from the abdomen, until hatching time when they are deposited into crevices and other sheltered locations. It usually takes 28 days for the capsule to hatch from the time it begins to form. Formation of the next egg capsule usually begins within a couple of weeks. The length of the egg stage varies from 14 to 35 days, with six to seven nymphal stages (instars) occurring over a period of 6 to 31 weeks. The life span of the adult female varies from 20 to 30 weeks. In one year over 10,000 descendants can be produced, assuming two generations per year.

### **Damage**

German cockroaches produce odorous secretions that can affect the flavor of various foods. When cockroach populations are high, these secretions may result in a characteristic odor in the general region of the infestation. Disease-producing organisms such as bacteria, protozoans, and viruses have been found on cockroach bodies. Different forms of gastroenteritis (food poisoning, dysentery, diarrhea, and other illnesses) appear to be the principal diseases transmitted by German cockroaches. The organisms causing these diseases are carried on the legs and bodies of cockroaches and are deposited on food and utensils as cockroaches forage. Cockroach excrement and cast skins also contain a number of allergens to which many people exhibit allergic responses, such as skin rashes, watery eyes and sneezing, congestion of nasal passages, and asthma.

### **Management**

Survey - To control German cockroaches, it is important to do a thorough inspection. A cockroach survey (trapping) is sometimes necessary to determine the extent of an infestation, as even a thorough inspection will not reveal all cockroach harborages or foraging areas. Surveys involve placing sticky traps at strategic locations within the building. Whenever possible, place survey traps either against a wall or in a corner of the floor, a shelf, or a drawer, or under equipment and counters. Most commercially available traps come complete with bait to encourage cockroaches to enter. One week of trapping at a sufficient number of trapping sites (ten or more) usually provides enough information for effective control.

### **Sanitation, Structural Modification, and Repairs**

It is difficult to keep cockroaches from entering homes via boxes, grocery bags, suitcases, and the like, but you can take steps to prevent a serious problem. A key factor in prevention is sanitation. Clean up all spilled foods, including crumbs on the floor. Do not leave dirty dishes overnight. Store items such as cereal, crackers, cookies, flour, sugar, and bread in airtight sealed containers. Empty garbage each evening into a sturdy container with a tightly fitted lid. Structural modifications such as caulking holes in walls where pipes pass through are necessary in the kitchen, bathroom, and other areas of the house in order to control German cockroaches.

### **Chemical Control**

Baiting is an effective method to control or eliminate German cockroaches. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin can provide a high level of control when applied to those areas where cockroaches harbor.

Some formulations of baits are available to the public in plastic feeding stations. Professional pest control personnel also have cockroach baits in flowable granular and gel formulations. Care should be taken to closely follow the label instructions for use.

Insecticidal dusts like boric acid, silica aerogel, and diatomaceous earth can provide additional control.

Apply dusts lightly, as heavy deposits may repel cockroaches. These products can be applied in the cracks and crevices of bureaus, clothes closet shelves, ceiling light fixtures, valances above windows, hollow legs of chairs and tables, and wall or floor cracks and crevices throughout the house. Do not place dusts where they could come in contact with children or pets. Do not allow children access to areas treated with boric acid. Boric acid is of low toxicity to adults, but it can present a hazard to children. Take precautions to assure that dusts do not contaminate food.

The use of residual insecticidal sprays or aerosol foggers within a structure is of little value in controlling German cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy.

- Apply crack and crevice treatments and/or gel baits to all cracks, crevices, and seams where cockroach activity is observed. Preferred habitats are in cracks between, under, and behind cabinets and where counter tops touch walls and sinks.
- Concentrate in kitchen, bathrooms, and any other room where food and/or water is readily available.
- Examine baseboards, ceiling trim boards, and wall paneling. Apply crack and crevice treatments of liquid, aerosol, or RTU insecticides or gel bait if signs of cockroaches are found.
- Examine large appliances for signs of cockroaches. Pay particular attention to areas under magnetic seals on refrigerator and freezer doors. If they are found, carefully apply crack and crevice liquid, aerosol, or RTU insecticides and/or gel baits to the infested areas.
- Examine wall decorations, like clocks and pictures, for the presence or evidence of cockroaches. Use freezing treatments, gel baits, or crack and crevice aerosols.
- Hollow locations such as table and chair legs are important harborages because they are easily overlooked. Treat these areas similarly as for crack and crevice locations, or carefully apply small amounts of dust. Baits are also especially effective in these locations.
- Look for possible cockroach habitats near electrical heat sources, like refrigerator compressors and fan motors.
- Small appliances, such as toasters and blenders, should be checked for signs of cockroaches. Gel baits, crack and crevice aerosols, or freezing are best treatments. Avoid insecticide contact with food contact surfaces.
- Wall, ceiling, or floor voids in kitchens and bathrooms are also favored habitats. Dusts, crack and crevice liquid, aerosol, RTU, or gel bait applications can be used in these locations. The most likely entrance into wall void areas is through openings around pipes under the sinks. Treat and seal these openings.

Never apply insecticides so food, dishes, or utensils can become contaminated.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

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Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

### **Oriental Cockroaches**

Oriental cockroaches feed on all kinds of filth, rubbish, and other decaying organic matter. They seem especially fond of garbage and the contents of discarded tin cans. If water is available, they can live for a month without food; without water they die within two weeks. The most important aspect of cockroach damage derives from their habit of feeding and harboring in damp and unsanitary places such as sewers, garbage disposals, kitchens, bathrooms, and indoor storage areas. Filth from these sources is spread by cockroaches to food supplies, food preparation surfaces, dishes, utensils, and other surfaces. Cockroaches contaminate far more food than they are able to eat.

Cockroaches in general produce odorous secretions from various points in their bodies. Such secretions can affect the flavors of various foods. When cockroach populations are high, these secretions may result in a characteristic odor in the general region of the infestation. Disease-producing organisms such as bacteria, protozoa, and viruses have been found in their bodies.

### **Gastroenteritis**

Different forms of gastroenteritis (food poisoning, dysentery, diarrhea, etc.) appear to be the principal diseases transmitted by Oriental cockroaches. The insects carry these disease-causing organisms on their legs and bodies and deposit the organisms on food and utensils as they forage. Cockroach excrement and cast skins also contain a number of allergens, to which many people exhibit allergic responses such as skin rashes, watery eyes, congestion of nasal passages, asthma, and sneezing.

### **Survey**

To control Oriental cockroaches, it is important to do a thorough inspection. A cockroach survey (trapping) is sometimes necessary to determine the extent of an infestation, because even a thorough inspection will not reveal all cockroach harborages or areas where they forage most actively at night. Surveys are particularly useful in houses and buildings where there is a moderate to heavy level of infestation. Cockroach surveys involve placing sticky traps at strategic locations within the building. Whenever possible place survey traps either against a wall or in a corner of the floor. Most commercially available traps come complete with bait to encourage cockroaches to enter. One week of trapping at a sufficient number of trapping sites usually provides enough information for more complete and effective control.



### **Sanitation, Structural Modifications, and Repairs**

Modifying the interior environment—removing food, moisture, and harborages for cockroaches—is the first step in treatment. Eliminating cockroach harborages involves caulking in closets and cabinets, caulking under the sink, etc., or making similar structural repairs in the kitchen, bathroom, and other areas of the house.

Oriental cockroaches may move into dwellings from the outside. Recent research has been conducted on the movement of Oriental cockroaches under, around, and into homes from harborages in crawl spaces and cinder block foundations. The research has shown that these cockroaches frequently move into the home along plumbing (e.g., up through the floor from underneath the crawl space) and under door or window jams. The use of screening, caulking and similar items may be useful in tightening the exterior to deter entry by the cockroaches.

### **Chemical Control**

Dusts such as boric acid, silica aerogel, and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices. Do not apply dusts to wet or damp areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them. Take care to keep children away from areas treated with boric acid. Take precautions to assure that the dusts do not contaminate food.

### **Perimeter Insecticide Sprays**

Perimeter insecticide sprays may aid in the reduction of Oriental cockroaches entering homes from the exterior. Sprays should be applied as to create a continuous barrier around the structure. Use only those materials labeled for this type of application. The use of residual sprays or aerosol foggers within a structure is of little value in controlling Oriental cockroaches. In fact, these applications may disperse the cockroaches making control difficult and lengthy. Baiting can be an effective method to control or eliminate cockroaches from a structure. Baits containing hydramethylnon, sulfluramid, boric acid, or abamectin should provide a high level of control when applied to those areas where cockroaches harbor. Care should be taken to closely follow the label instructions for use.

Oriental cockroaches require cool temperatures, high moisture, and readily available drinking water. They can occur in many of the locations mentioned earlier for German cockroaches, but concentrate in basements, bathrooms, laundry rooms, and under the kitchen sink. Follow the same treatment recommendations as for German cockroaches plus add those listed here.

### **Outdoors Cockroach Treatment**

- Investigate crawlspaces and basement areas containing exposed soil. If cockroaches or signs are found, make crack and crevice liquid, aerosol, or RTU applications to headers, undersides of floor joists, around vents and windows, and sill plate areas. You may also want to apply gel baits or tamper-proof bait stations.
- Make a band/perimeter treatment with a liquid, aerosol, or RTU insecticide to all external entry areas (especially thresholds), to the entire perimeter of basement foundation, and to other slab construction areas (garage, porches, sidewalks, and stairways).
- Make a crack and crevice and/or spot treatment with a liquid, aerosol, or RTU insecticide to all exterior utilities entering the structure (telephone, cable TV, natural gas, water). Seal utility entrances.
- Make spot treatments with either gel bait or tamper-proof bait stations underneath sinks and tubs, behind water and gas meters, around floor drains, underneath water heaters, and around humidifiers.
- Reapply treatments to all exterior areas mentioned as needed during warmer months.
- Reduce vegetation near the foundation of the house.

Common names (the names found on the list of active ingredients) of other effective pesticides include: propoxur (Baygon), cyfluthrin, permethrin, deltamethrin, and tetramethrin. A variety of formulations may be available, including sprays (liquid or wettable powders), aerosol sprays, baits or dust.

No single chemical or formulation will control all cockroaches.

Some German cockroach infestations are resistant to one or more insecticides. Apply insecticides only to cracks, crevices, or unexposed surfaces, and not beyond the point of runoff. Avoid spraying carpets, wallpapers, or other furnishings that might be stained.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

**NOTE:** When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

## **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)

# Labeling Information

<b>EACH PESTICIDE HANDLER EMPLOYEE MUST HAVE AN UNDERSTANDING OF THE FOLLOWING SUBJECT AREAS TO SAFELY USE AND HANDLE PESTICIDES:</b>
<b>PESTICIDE PRODUCT LABELING</b> - Format and meaning of information, such as the precautionary statements concerning human health hazards.
<b>HAZARDS OF PESTICIDES</b> - These are identified in product labeling, Safety Data Sheets (SDS), or PSIS Leaflet (Pesticide Safety Information Series).
<b>PESTICIDE SAFETY REQUIREMENTS AND PROCEDURES</b> - This in regards to regulation, PSIS Leaflets, SDS, Including Engineering Controls, for handling, transporting, storing and disposal of Pesticides.
<b>ENVIRONMENTAL CONCERNS</b> - This addressess the aspect of drift, runoff, and the hazards to Wildlife.
<b>ROUTES OF ENTRY</b> - This area addressess the hazards of which Pesticides can enter the body: Dermal (skin) , Oral (swallowed), Inhalation (breathe in), Ocular (through the eyes).
<b>COMMON SIGNS AND SYMPTOM OF EXPOSURE</b> - Some of the basic symptoms include: Headache, fatigue, weakness, nervousness, nausea, perspiration, eye and skin irritation.
<b>EMERGENCY FIRST AID</b> - Know and understand the basic procedures necessary for first aid concerning exposure to pesticides. This may include basic CPR.
<b>USE AND CARE OF PERSONAL PROTECTIVE EQUIPMENT</b> - 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.
<b>THE ITEMS LISTED ABOVE ARE JUST BASICS REQUIRED TO SAFELY HANDLE PESTICIDES</b>

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

## Safe Operation of Equipment

A handler employer must assure that handlers are instructed in the safe operation of all equipment they will be using. It is the handler-employer's responsibility to assure that the equipment is working properly and to inform employees, when appropriate, that the equipment may be contaminated with pesticides and to explain the correct way to handle such equipment.

## Personal Protective Equipment

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

## Decontamination

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

## Emergency Assistance

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

## Label Requirements

When these requirements appear on pesticide labels, all end-users must meet them unless exempt. Exempt end-users should voluntarily obey the requirements because of the dangers of pesticide exposure. These require employers to make sure that employees are provided with:

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

## Enforcement

States have primary enforcement responsibility for pesticide use violations if the Administrator of the EPA determines the State:

- (1) has adopted adequate pesticide use laws and regulations;
- (2) has adopted or is implementing adequate procedures for the enforcement of its laws and regulations; and
- (3) has kept records and made reports showing compliance with (1) and (2) above, as the Administrator may require by regulation.

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

Violations of the WPS carry both civil and criminal penalties.



## Appendix A Criteria for WPS Pesticide Safety Poster

### Each WPS safety poster must convey to workers and handlers

1. That there are federal rules to protect them, including a requirement for safety training.
2. How to help keep pesticides from getting on or into their bodies. The poster must include the following instructions:
  - Avoid getting on your skin or into your body any pesticides that may be on plants and soil, in irrigation water, or drifting from nearby applications.
  - Wash before eating, drinking, chewing gum, using tobacco, or using the toilet.
  - Wear work clothing that protects your body from pesticide residues, such as long-sleeved shirts, long pants, shoes, socks, and hats or scarves.
  - Wash or shower with soap and water, shampoo your hair, and put on clean clothes after work.
  - Wash work clothes separately from other clothes before wearing them again.
  - Wash immediately in the nearest clean water if pesticides are spilled or sprayed on your body. As soon as possible, shower, shampoo, and change into clean clothes.
  - Follow directions about keeping out of treated or restricted areas.

### Appendix A Criteria for WPS Materials

#### Requirements for Warning Signs

##### 1. Required Words

- The words “DANGER — PELIGRO” and “PESTICIDES — PESTICIDAS” must be located at the top of the sign and “KEEP OUT—NO ENTRE” at the bottom.

##### Exception

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

- The words must be clearly legible.

##### 2. Required Design

- A circle containing an upraised hand on the left and a stern face on the right must be near the center of the sign.
- The background outside the circle must contrast with the inside of the circle.
- The hand and a large portion of the face must contrast with the inside of the circle.
- The remainder of the inside of the circle must be red.
- The length of the hand must be at least twice the height of the smallest letters.
- The length of the face must be only slightly smaller than the hand.

##### 3. Additional Information

You may put additional information on the warning sign, such as the name of the pesticide and the date of application, if it does not detract from the appearance of the sign or change the meaning of the required information.

##### 4. Size

The signs must be at least 14 inches by 16 inches, and the letters must be at least 1 inch high.

## **Exception**

On farms and in forests, you may use smaller signs if the treated area is too small to accommodate 14- by 16-inch signs. For example, when a single plant needs to be posted, a smaller sign would be appropriate. In nurseries and greenhouses, you may use a sign smaller than the standard size. Whenever a small sign is used, there are specific posting distances depending on the size of the lettering and symbol on the sign.

*Signs with the words “DANGER” and “PELIGRO” in letters less than 7/16 inch in height or with any words in letters less than 1/4 inch in height or with the circle graphic containing an upraised hand and a stern face less than 1½ inches in diameter do not meet.*

*WPS sign requirements.* \* This distance requirement is for places where multiple signs are used to post a single treated area, such as a nursery or a greenhouse section. It does not apply where individual signs are used for separate small treatment areas (such as single potted plants in a greenhouse).

## **Appendix A Criteria for WPS Materials**

### **Criteria for Worker Training**

1. WPS training for workers must include at least the following information:
  - Where and in what form pesticides may be encountered during work activities.
  - Hazards of pesticides resulting from toxicity and exposure, including acute effects, chronic effects, delayed effects, and sensitization.
  - Routes through which pesticides can enter the body.
  - Signs and symptoms of common types of pesticide poisoning.
  - Emergency first aid for pesticide injuries or poisonings.
  - How to obtain emergency medical care.
  - Routine and emergency decontamination procedures, including emergency eyeflushing techniques.
  - Hazards from chemigation and drift.
  - Hazards from pesticide residues on clothing.
  - Warnings about taking pesticides or pesticide containers home.
  - An explanation of the WPS requirements designed to protect workers, including application and entry restrictions, design of the warning sign, posting of warning signs, oral warnings, availability of specific information about applications, and protection against retaliatory acts.
2. WPS worker training materials must use terms that the worker can understand.

## **Appendix A Criteria for WPS Materials**

### **Criteria for Handler Training**

WPS training for handlers must include at least the following information:

- Format and meaning of information on pesticide labels and in labeling, including safety information such as precautionary statements about human health hazards.
- Hazards of pesticides resulting from toxicity and exposure, including acute effects, chronic effects, delayed effects, and sensitization.
- Routes through which pesticides can enter the body.
- Signs and symptoms of common types of pesticide poisoning.
- Emergency first aid for pesticide injuries or poisonings.
- How to obtain emergency medical care.
- Routine and emergency decontamination procedures, including emergency eyeflushing techniques.



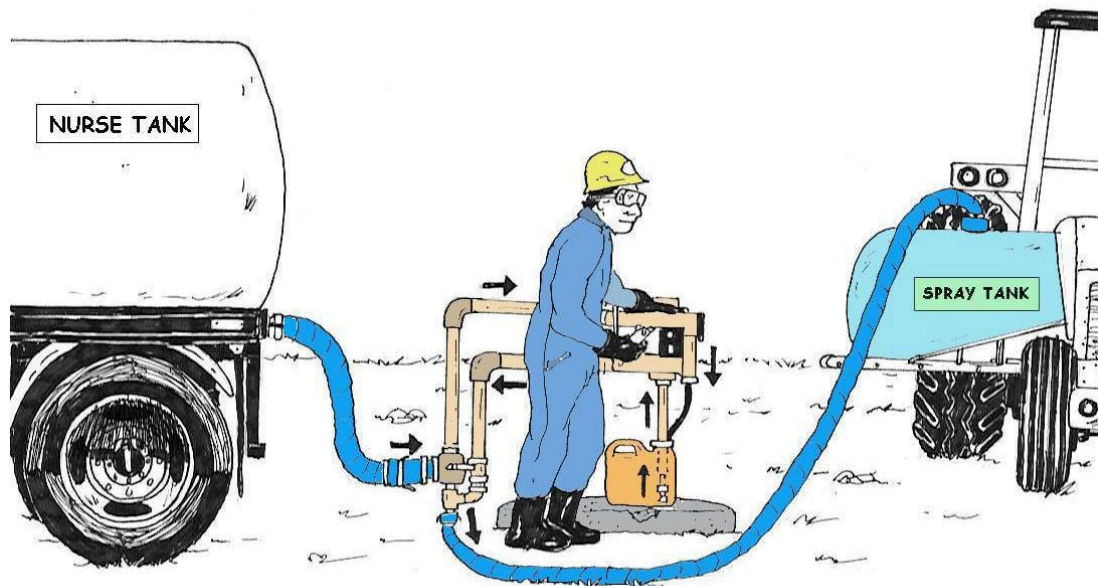
- Need for and appropriate use of personal protective equipment.
- Prevention, recognition, and first aid treatment of heat-related illness.
- Safety requirements for handling, transporting, storing, and disposing of pesticides, including general procedures for spill cleanup.
- Environmental concerns such as drift, runoff, and wildlife hazards.
- Warnings about taking pesticides or pesticide containers home.

An explanation of WPS requirements that handler employers must follow for the protection of handlers and others, including the prohibition against applying pesticides in a manner that will cause contact with workers or other persons, the requirement to use personal protective equipment, the provisions for training and decontamination, and the protection against retaliatory acts.

### Restricted Use Products (RUP) Report

The Restricted Use Products Report is a compilation of both active and cancelled pesticide products classified as "Restricted Use". The "Restricted Use" classification restricts a product, or its uses, to use by a certified pesticide applicator or under the direct supervision of a certified applicator. (For detailed information on the "Restricted Use" Classification, consult 40 CFR Subpart I, 152.160)

In the RUP Report, the criteria on which the restricted use classification is based, uses, formulations, EPA Registration Numbers, product names, product status and revision date are organized by pesticide active ingredient (AI). The Product Manager (PM) Number is also provided for each AI.



### Pesticide

Though often misunderstood to refer only to *insecticides*, the term pesticide also applies to herbicides, fungicides, and various other substances used to control pests. Under United States law, a pesticide is also any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.



## Topic 4 –Advanced Cockroach Management Section Post Quiz

1. What is the control method called that has a coarse spray of liquid insecticide or application of a dust insecticide over a large area; should be evenly distributed?
2. What is the control method called that has careful placement of tamper-proof bait stations in areas inaccessible to children and pets and near existing cockroach infestations?
3. What pesticides were frequently used in the past, but many of them have been banned because of their negative effects on health and environment?
4. What pesticides are synthetic kinds of the natural pyrethrin and produce toxic effect on the nervous system?
5. What ingredients are designed to preserve the active ingredients, make them easier to apply or improve their killing ability?
6. What is a generic term for compounds containing the elements boron and oxygen?
7. Pyrethroids are the man-made versions of pyrethrins, natural insecticides from?
8. Which pesticide is a white powder with a moldy odor?
9. Insect growth regulators (**IGRs**) have low \_\_\_\_\_, but have long residual effectiveness.
10. Which two products are simply irresistible and if used together will eradicate most infestations?

## **Answers to Post Quizzes**

### **Topic 1 - Cockroach Introduction**

1. F, 2.T, 3.F, 4., 5.F, 6.F, 7.T, 8.F, 9.F, 10.F

### **Topic 2 - Common Cockroach Classifications and Sub-Families**

1. German cockroach, 2. Brownbanded, 3. 30 to 40 eggs, 4. Nymphs, 5. Four, 6. Allergic reactions, 7. Largest, 8. Male and female, 9. Woodpiles, 10. Smokybrown cockroach

### **Topic 3 - Cockroach Inspection and Treatment Section**

1. Water, 2. Infestations, 3. Aggregation pheromone, 4. 7-10, 5. Integrated Pest Management (IPM), 6. Synthetic, 7. Cracks and crevices, 8. Insecticide dust, 9. Non-residual spray, 10. Demon WP

### **Topic 4 –Advanced Cockroach Management Section**

1. Broadcast, 2. Bait Station Placement, 3. Organochlorine, 4. Pyrethroid, 5. Inert, 6. Borate, 7. Chrysanthemum flowers, 8. Fipronil, 9. Human toxicity, 10. Maxforce and Avert

# Insect Glossary

**Adventive:** Located outside habitat, though a reproductive population may not be established.

**Alates:** Winged forms of insects.

**Anthocorids:** A true bug in the family Anthocoridae.

**Aphid:** An insect in the family Aphidiidae which are sometimes called plant lice.

**Alien:** Same as non-native.

**Beneficial insect:** Any insect that has a lifestyle that is advantageous to man. Insects that preserve the balance of nature by feeding on others; pollinators and recyclers are examples of beneficial insects.

**Cephalothorax:** Head (ceph) and chest (thorax) area.

**Cerci:** Paired appendages on the end of the abdomen of many insects, which are used for sensing, defense, or mating.

**Chewing (mouth parts):** Any mouth part that literally bites to feed; other mouth part types are sucking and rasping.

**Clavus:** The enlarged terminal antennal segments that form a club.

**Collophore:** A tube-like structure on the underside of the first abdominal segment (folds under the body) of Collembola (e.g. springtails) that is used as a spring action for leaping.

**Colonizing:** An ant species which is successful at creating nests in new areas. While some exotic ants are successful colonizers, many colonizing species are not exotic -- and many exotics are not colonizers.

**Compound eyes:** The large multi-faceted eyes of insects.

**Coreids:** A member of the family Coreidae which are leaf footed bugs.

**Corium:** The elongated, thickened basal portion of the fore wing of Hemiptera.

**Cornicles:** Tubular structure on each side of abdominal region from which pheromones or honeydew is expelled.

**Coxa** (pl.=coxae): Basal portion of the leg.

**Crepuscular:** Having activity periods during low light levels at dawn and evening.

**Cursorial:** Adapted for running.

**Dactyl:** Literally a finger or fingerlike projection on an insect body part.

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

**Defoliate, defoliation:** Removal of foliage from plants, often by chewing insects.

**Detritivore:** Any organism that eats decaying organic matter.

**Diapause:** An insect resting stage, usually induced by environmental signals or extreme conditions, like winter or summer.

**Dimorphic:** Having two distinct forms.

**Endosperm:** A portion of a seed that contains most of the energy reserves for germination.

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

**Exoskeleton:** The outer portion of an insect body, which may be relatively soft like a caterpillar or hardened like many beetles.

**Femora:** A segment of an insect leg; usually the largest segment.

**Filiform:** Linear shaped, as the antennae of ground beetles.

**Forbs:** Any broadleaf, non-woody (herbaceous) plant.

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

**Furculum** (plural: furcula): The elongated fork-like appendage on the end of the abdomen.

**Exotic:** Same as non-native.

**Genera:** Plural of genus; A genus is a group of plants or animals with similar characteristics. Animals (insects) are classified by kingdom, phylum, class, order, family, genus, species, and author's name. For example, the honey bee is classified as Animal (kingdom), Arthropoda (phylum), Insecta or Hexapoda (class), Hymenoptera (order), Apidae (family), *Apis* (genus), *mellifera* (species), Linnaeus (author's name). The genus and species are always italicized.

**Girdle, girdling:** Damage of a plant that circles the stem or branch, cutting off the connective plant tissue.

**Grigology:** The study of crickets, grasshoppers, and katydids.

**Hemelytron:** The first wing of a true bug (Hemiptera) which has the base more thickened than the membranous outer portion.

**Hopperburn:** Leaf damage caused by leafhopper feeding, which is a yellowing of the leaves.

**Imago:** The adult stage of an insect.

**Instar:** An insect stage between molts; molting is growth.

**Internode:** The part of a plant stem between the nodes. Nodes mark the point of attachment of leaves, flowers, fruits, buds, and other stems.

**Introduced:** Same as non-native.

**Invasive:** A species that 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 species.

**Larval stage (larva, larvae):** An immature insect sometimes used to include all immature stages, even eggs. Usually this term refers more specifically to the feeding stages of insects with complete metamorphosis, like grubs, caterpillars, and maggots.

**Maggot:** In most Diptera (flies), legless larva lacking a distinct head, with cephalic (head) end pointed and caudal (rear) end blunt.

**Mesophyll:** Fleshy plant tissue inside a leaf or stem.

**Metamorphosis:** A change in form during an insect's growth and development.

**Metathorax:** The second section of the insect thorax which houses the second pair of legs and the first pair of wings.

**Mite:** A member of the order Acari (ticks and mites).

**Molt, molting process:** In insects, as in snakes, the process of shedding the exoskeleton.

**Naiad:** A term for immature insects that are aquatic from the orders Plecoptera, Odonata, and Ephemeroptera. This term is becoming archaic and is now replaced by the more general term "*immature*" insect.

**Necrosis:** Death of tissue in plants or animals.

**Nymphs:** An immature stage of hemimetabolous insects (those with incomplete metamorphosis).

**Native:** These definitions do not necessarily define *where* a species is native. How do I define where a species is native? Sometimes the non-native status of a species is clear from previous collections and existing knowledge from biogeography and systematics. Other times, boundaries are a lot blurrier. Is a species non-native if it has been there for 400 years?

**Non-indigenous:** Same as non-native.

**Non-native:** A species that is established outside its native habitat. With respect to ants, ants not in an established reproducing colony.

**Oothecae:** A bean-like hardened egg capsule produced by female Ants.

**Osmeterium** (pl.=osmeteria): Scent-producing area behind the tibia.

**Overwinter:** Time spent during the winter months. Insects are often in hibernation or at least rather immobile in the colder temperatures.

**Ovipositor:** The egg laying apparatus of an insect. The stinger of a bee is actually a modified ovipositor.

**Parthenogenesis:** Egg development without fertilization.

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

**Petiole:** Attachment of a leaf to stem.

**Phloem and Xylem:** Vascular tubes that allow fluid transport in plants. It is the way plants receive and distribute nutrients, hormones, and water.

**Photosynthesis:** The chemical process that plants use to convert carbon dioxide and water to sugars and ultimately to energy.

**Phyto-** (prefix): Plant.

**Phytophagous:** Plant eating; an insect using plants as a food source.

**Phytotoxemia:** A toxic reaction in plants.

**Poikilotherm:** A cold-blooded organism.

**Proboscis:** A nose, or in the case of butterflies, the coiled sucking mouthpart.

**Pronotum:** The plate on top of the prothorax.

**Prothorax:** The front part of an insect thorax that includes the attachment points for the front legs.

**Protozoan:** A microorganism in the kingdom Protozoa.

**Pseudergates:** Caste found in the lower termites (Isoptera), comprised of individuals having regressed from nymphal stages by molts eliminating the wing buds, or being derived from larvae having undergone non-differentiating molts, serving as the principle elements of the worker caste, but remaining capable of developing into other castes by further molting.

**Psocids:** Any insect in the order Psocoptera, which includes booklice and barklice.

**Psyllid yellows:** A virus disease of potatoes, tomatoes, peppers, and eggplant. See purple top.

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

**Purple top:** A purple discoloration of foliage tips caused by insect transmitted virus.

**Pustulate:** Pus-forming, as in spider bites.

**Rhopalid:** An insect in the family Rhopalidae in the order Hemiptera (true bugs).

**Rosetting:** Malformation of a plant resulting in a bunched irregular growth of the leaves.

**Scutellum:** A triangular shaped section on the back of Hemiptera and some Coleoptera. It is often the identifying characteristic of Hemipterans or true bugs.

**Secondary reproductive:** A caste of subterranean termite; also called supplemental reproductives; If these termites develop from nymphs, they are called secondary reproductives (primary reproductives are the king and queen). If they develop from pseudergates, they are called tertiary reproductives. Supplementals may be responsible for most of the egg production in the colony.

**Spinneret:** A small tubular appendage from which silk threads by spiders and many larval insects.

**Stippling (leaf):** A speckled appearance of a leaf, usually yellowish spots on a green leaf.

**Stolon:** An underground portion of a plant that grows horizontally, as in sod-forming grasses.

**Subgroup:** A subset of a group with related characters. The term group is a general and non-specific collection of similar organisms regardless of taxonomic hierarchy.

**Subimago:** The first winged stage of a mayfly. This is the only group to have a winged stage that molts. The final stage is the imago, or adult.

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

**Tegmina:** Plural of tegmen, a hardened covering like the forewing of many Orthoptera and Hemiptera.

**Tenaculum:** A minute 2-pronged structure on the underside of the third abdominal segment of Collembola (springtails), which holds the furcula (appendage used for jumping) before it is released to jump.

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

**Soldier termite** - A caste of termites with specific structures to defend the colony, such as large mandibles or nasute mouths that produce sticky defensive substances.

**Worker termite** - A caste of termites that do most of the work in the colony. Worker termites can be all immature termites and forms that do not develop into reproductive forms or soldiers.

**Tertiary reproductive termite:** See secondary reproductive.

**Tettigoniid:** A family of Orthoptera often called long-horned grasshoppers, which includes katydids.

**Thorax:** The second body segment of an insect. The thorax has all of the wings and legs attached to it.

**Tip burn:** A yellow or dried tip on a branch or leaf caused by insect feeding or a plant physiology disorder.

**True bugs:** Insects in the order Hemiptera. They are usually characterized by a scutellum, a triangular-shaped section on the back.

**Tramp:** A widespread ant species spread by human commerce with a specific syndrome of life history characteristics: extreme polygyny, unicolonial or highly polydomous nest structure, and colony reproduction by budding.

**Transferred:** Collected outside native habitat, without knowledge of established nests.

**Transported:** Same as transferred; often refers to animals found in quarantine inspection.

**Venation:** The pattern of veins in the insect wing or in plant leaves.

**Wing pads:** Incomplete wing structures, like those formed on immature grasshoppers.



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