

Insect Pests and Control

Insects are among the most important and numerous of the pests plaguing the food processing industry. Although only a portion of the many hundreds of insects that are found in the plants cause serious damage to the final product, no insects are allowed in the final product.

One important aspect in managing insects is knowing about the insect. Where the insect likes to spend its time, what foods the insect prefers, what conditions the insect does not like, how the insect develops, etc., are vital pieces of information necessary for a good management program. Without these pieces of information the pest management program is really nothing but responding to problems and not solving the problem.

Food processing insects can be divided into three broad groups: the beetles, the moths and others that include roaches, mites, silverfish, etc.

Beetles and Moths

Beetles and moths have one thing in common. They both have four life stages: egg, larva, pupa and adult. The pupa is the stage in which the larva changes into the adult. Although the adults of beetles and moths do not look alike, the other stages do have some similarities. Basically, the larva is the “grub or worm” stage and does not look like the adult. Larva of both beetles and adults may feed on raw food or processed food. Both beetle and moth larva have chewing mouthparts. When an inspection finds an insect larva, it will either be a beetle or moth. They can be separated by looking at the back half of the larva. If there are legs present, the larva is a moth larva. If legs are missing they are beetle larva. There are some exceptions, but for the major beetles and moths found in food processing plants, this rule will hold. The pupa is the stage in which the larva changes into an adult. There is no feeding during the pupa stage. Adult beetles are raw and processed food feeders. They have chewing mouthparts. Adult moths do not feed on raw or processed food because they have sucking mouthparts. However, moths can contaminate the final product by being “packaged” if the

moths are in the packaging area. Not all beetles or moths present in a food processing facility are insects that will feed off raw or processed food. Some are just there. Somehow they got into the plant. During the summer, this may apply to ground beetles which wander into buildings. Some may be attracted to problem areas in the facility such as a wet area in which mold is growing. There are many mold-feeding insects that can be a nuisance in food plants.

Others

Most insects in “others” undergo what is called gradual metamorphosis. This means they have basically three life stages: egg, nymph and adult. The nymph looks similar to the adults, and has similar habits, ecological preferences and food choices as the adult stage. In most groups, the difference is nymphs do not have wings whereas the adults do have wings.

Moths

Moths and butterflies are familiar four-winged insects characterized by the flat, overlapping scales and hairs that, in most cases, completely clothe the body, wings and other appendages. These insects develop by complete metamorphosis with four stages in their life cycle: egg, larva (or caterpillar), pupa and adult. They have chewing mouthparts in the larval stage and coiled sucking mouthparts as adults. The larvae, unlike the beetle larvae, have abdominal legs. Moths are most active during dawn, dusk and at night.

Most larvae are important pests of stored products. Although the adults are important for reproduction, the larvae consume and contaminate our food. They often leave the infested products and move about inside the structures, leading to other problems. Excessive populations can spread bacteria and molds. Moths will also attack fabrics and other material of animal origin such as woolens (clothing, carpets, upholstery, tapestry, etc.), fur and feathers. Such damage usually occurs when clothes are stored for an extended period of time. Some of the more common and important moths are discussed below.

Almond Moth (*Cadra cautella*)

The adult almond moth has 4 wings, with about 5/8-inch wing spread. The forewings are brown to gray with a pale wavy band near the tip and darker band across the middle. Larvae of the almond moth are dirty white, with brown or black spots along their back. Larvae increase to about 1/2 inch long when fully grown. Almond moths can produce five to six generations per year.

Although they can be found in dried fruits, nuts and pet foods, they are most frequently found infesting various candies composed of chocolate and nuts.

Indianmeal Moth (*Plodia interpunctella*)

The adult Indianmeal moths have four wings with a spread of 3/4 inch. Their forewings are gray near their body and reddish near the tip. Both their head and thorax have a reddish color. When fully grown, the larvae of the Indianmeal moth leave a silken thread behind wherever they crawl. This webbing can be found on or near the surface of the food where they feed. Indianmeal moths can produce five to six generations per year.



Figure 3. Indianmeal Moth, Spread (l), Resting (r).

Indianmeal moth larvae feed on as wide a range of foods as any food-infesting insect. They prefer the coarse grades of flour and milled products and are commonly found in packaged cornmeal, whole-wheat flour and various prepared flours. They also feed on many types of grains and grain products, garden seeds, oil seeds, nuts, peas and beans and their products, spices, powdered milk, chocolate, dried fruits and vegetables, drugs, dried pet foods and many others. In large, crowded populations, they are cannibalistic, especially on larvae in cocoons and pupae.

Control Considerations

1. The prime consideration should be avoidance. All products entering the premises should be carefully examined and rejected or heat-treated or fumigated.

2. Sanitation is a must! Remove pockets of infested foods in machinery, buildings and warehouses. Remove accumulations of dust, flour and other materials in which the insects can feed and breed.
3. Infested material can be heat-treated, 140 degrees F for one hour or 120 degrees F for two hours. Cold treatment (cooling) has been shown to be a viable suppression technique but has not been advocated as an elimination process because some strains of Indian meal moths can undergo extended resting periods (diapause) at reduced temperatures.
4. Properly labeled residual insecticides can be applied to grain; however, the webbing should be removed first.
5. Properly labeled space sprays can be used to kill moths. Evening applications are generally preferable since the moths tend to be most active during this period.
6. In some circumstance, spot or general fumigations are required.
7. Some studies have shown that a hymenopterous parasite, *Bracon hebetor* Say, provides control of the larvae.

Mediterranean Flour Moth (*Anagasta kuehniella*)



Figure 4. Mediterranean Flour Moth

The adult Mediterranean flour moth has four pale gray wings with a wing spread of 3/4 inch. Their forewings are a pale leaden gray with transverse, wavy, black markings. The adult moths rest with their head and thorax held high. Larvae have lateral dark spots on each segment of their abdomen distinguishing the Mediterranean flour moth from the Indianmeal moth. The larvae of the Mediterranean flour moth spin silken thread wherever they go and web and mat together particles of food on which they are feeding. The larvae will leave the feeding area to pupate.

The Mediterranean flour moth prefers flour but infests wheat, bran, nuts, chocolate, seeds, biscuits, beans and dried fruits.

Mealmoth (*Pyralis farenalis*)

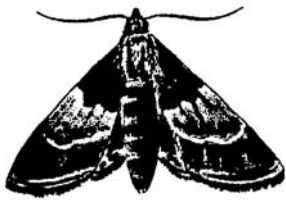


Figure 5. Mealmoth.

The forewing of the adult meal moth is light brown with dark-brown patches at the bases and tips. Also, each forewing has two wavy, transverse white lines. The larvae of the mealmoth are whitish, and about 1 inch long when fully grown. The larva shows a contrast between the black of the head and the first body segment and the white of the remainder of the body. The body of the larva is often tinged with orange toward each end. Mealmoths produce three to four generations per year.

Mealmoths are usually found feeding on damp or spoiled grain, bran or meal. To eliminate moth infestation of food and stored-grain products, you must find and destroy infested material; then treat the area where they were stored. Infested materials can be fumigated to eliminate the infestation. To keep areas or product from becoming reinfested, a thorough cleaning is essential. This begins by removing any spilled foods, then maintaining a good housekeeping program.

Beetles and Weevils

Worldwide, there are more than 250,000 species of beetles, some of which are found in homes and buildings where they feed upon our food, carpets and the building structure. Beetles and weevils are distinguished from other insects by the peculiar hardened forewings known as elytra that meet in a straight line over the middle of the abdomen. The primary difference between beetles and weevils is that weevils have a head with a beak or snout while beetles do not have this characteristic.

As noted earlier, these insects develop through complete metamorphosis with four stages in their life cycle: egg, larva, pupa and adult. The larvae may be slender and active, as with many stored-food beetle larvae, or clumsy, relatively inactive grubs. Beetle larvae have thoracic legs, whereas weevil larvae are legless.

Lesser Grain Borer (*Rhizoperth dominica*)

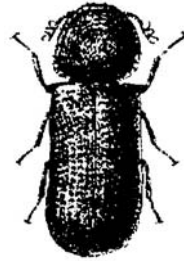


Figure 6. Lesser Grain Borer.

The lesser grain borer is one of the smallest beetles injurious to grain in this country. The adult is readily distinguished from other grain pests by its slender cylindrical form and small size. It is polished dark brown or black, with a somewhat roughened surface. The dimensions of the lesser grain borer are about 1/8 of an inch long and 1/32 of an inch wide. This grain borer belongs to family of beetles that has the head turned down under the thorax and is armed with powerful jaws. Both the adults and larvae cause serious damage to a great variety of grains.

Each female lays 300 to 500 eggs and deposits them, singly or in clusters, upon the loose grain. The eggs hatch in a few days, and the small whitish grubs, or larvae, crawl actively about the grain, feeding on the flour produced by the boring adults, or they bore directly into kernels, especially those that have been slightly damaged. The larvae complete their growth within the kernel, transform into white pupae, and then change into adults. They then cut their way out of the kernel.

The lesser grain borer is primarily a pest in whole grains; however, it is capable of infesting other materials such as flours, dry dog food, edible legume seeds, wood, cork, macaroni, edible bulbs and tapioca roots. This insect commonly penetrates packages of foods in storage or in rail cars.

Control Considerations

1. For small infestations, locate the infested materials and destroy or use heat or freezing.
2. In stored grain, use approved fumigation procedures and/or protective chemicals, or use aeration with cool air to retard insect activity and development.

Cigarette Beetle (*Lasioderma serricorne*)

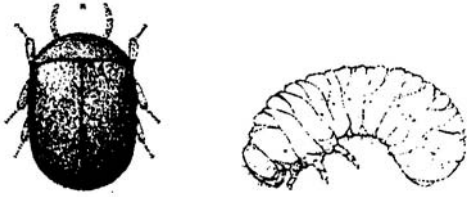


Figure 7. Cigarette Beetle adult (l), larva (r).

The cigarette beetle is a small stout, oval, reddish-yellow or brownish-red beetle, with the head bent down nearly at a right angle to the body. This gives the beetle a humped appearance when viewed from the side. It varies in size, but is usually about 1/10 of an inch long. Cigarette beetles breed in a variety of seeds and may occasionally be found attacking grains left in storage. The antennae of the cigarette beetle are saw-like and the head is somewhat retracted.

The adult cigarette beetle lives 2 to 4 weeks, during which time each female may lay as many as 100 eggs. The developmental period from egg to adult is quite variable but, under favorable conditions, is 6 to 8 weeks.

Cigarette beetles are primary pests of stored tobacco, yet they will occasionally attack stored grain and cereal products. Breeding can occur in rice risings, ginger, pepper, dried fish, seeds and cereal products.

Control Considerations

1. In food processing plants, managers must establish an inspection routine for all raw materials. Properly labeled chemicals can also be used for control of adults that are outside of foods/containers.
2. All infested articles must be located and destroyed.
3. Infested food materials in smaller containers can be destroyed by freezing (0 degrees F for 5 to 7 days) or by heating (as in an oven at 140 degrees F for 30 minutes).
4. Properly labeled insecticides can be used as sprays to provide some control of adults that are outside of foods/containers (sprays will not affect larvae and adults in foods or inside containers).
5. In warehouses/storage facilities, properly labeled fumigants, fogs and vapors can be used for control (however, there are significant limitations related to these types of products).

Drugstore Beetle (*Stegobium paniceum*)

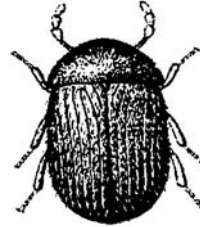


Figure 8. Drugstore Beetle.

The drugstore beetle and the cigarette beetle are similar in appearance. The adults are about 1/10 of an inch in length, cylindrical and uniform brown with fine silky hairs. The cigarette beetle adult has a stout, oval, reddish yellow or brownish-red body with the head bent down at right angles to the body. The adult drugstore beetle has a three-segmented, saw-like antennae that is pressed to the body when at rest.

This beetle lays eggs in almost any dry organic substance. The small white grubs or larvae emerge from the eggs and then tunnel through these substances. When fully grown, they pupate in small cocoons. The entire life cycle may be passed in less than two months. Note: This species is not reportedly encountered as frequently as the cigarette beetle, but control measures would be similar.

Confused Flour Beetle (*Tribolium confusum*)

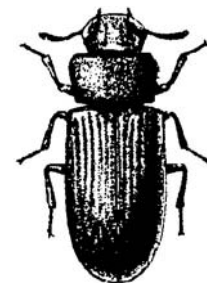


Figure 9.
Confused Flour Beetle.

The confused flour beetle is a shiny, flattened, oval, reddish-brown beetle about 1/7 of an inch long. The head and upper parts of the thorax are covered densely with minute punctures. The wing covers are ridged lengthwise and are sparsely punctured between the ridges.

The average life of these beetles is about one year, but some have been known to live almost four years. The female loosely lays an

average of about 450 small, white eggs in flour or other food material. Confused flour beetle eggs are covered with a sticky secretion and thus become covered with flour or meal. These eggs also readily adhere to the sides of sacks, boxes and other containers.

When fully grown, the larvae transform into small, naked pupae. Although they are white initially, the pupae gradually change to yellow and then to brown and, shortly afterwards, transform into adult beetles. Under favorable conditions, the period from egg to adult averages about 6 weeks.

Confused flour beetles are generally feeders of all cereal products. These flour beetles have been found feeding on more than 100 different foodstuffs. Common items infested include grain, seeds, flour, meal, cereal products, animal matter, wood, vegetables, drugs and spices. They have also been found to infest peas, beans, cottonseed, cracked nuts, dried fruits (especially raisins), grits, snuff, baking powder, milk chocolate, yeast, powdered milk, insect collections and eggs and larvae of their own species and of others.

Control Considerations

1. Inspect all new susceptible products (start with insect-free raw materials).
2. In mills, it is helpful to use impact machines (entoleters) as grain is taken in to destroy flour beetles in all life stages. Insects and their fragments may be removed by aspiration after impacting.
3. Use constant monitoring/inspection programs.
4. Fumigate infested products prior to acceptance/unloading.
5. Use all sanitation practices possible to insure plants are maintained in clean condition.
6. Apply approved residual pesticides where they are labeled for use (note, however, that resistance has been reported to several products).
7. Infested materials can be heated to 140 degrees for one hour or 120 degrees for four hours (as long as the maximum temperature reaches the center of the containers or mass). Also, infested products can be stored in subfreezing temperatures for a week for control of the flour beetles.

Red Flour Beetle (*Tribolium castaneum*)

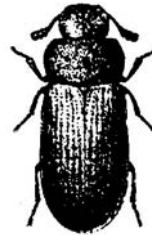


Figure 10. Red Flour Beetle.

The red flour beetle is almost identical in appearance to the closely related confused flour beetle. It can be distinguished from the confused flour beetle only with the aid of a magnifying glass. However, the red flour beetle can fly, while the confused flour beetle cannot fly. The segments of the confused flour beetle antennae gradually increase in size from the base to the tips, whereas the last few segments of the red flour beetle antennae are abruptly larger than the other segments, forming enlarged tips. The head margins of the confused flour beetle are expanded and notched at the eyes, with a ridge over the eye. The head margins of the red flour beetle are nearly continuous at the eyes and do not have a ridge over the eyes.

This insect is constantly associated with the confused flour beetle and has similar feeding and breeding habits.

Sawtoothed Grain Beetle (*Oryzaephilus surinamensis*)



Figure 11.
Sawtoothed Grain Beetle.

The sawtoothed grain beetle is one of the best known of the cosmopolitan grain pests. It is a slender, flat, brown beetle about 1/10 of an inch long. It gains its name from the peculiar structure of the thorax, which bears six sawtooth-like projections on each side. It attacks, in both the larval and adult stages, all food of vegetable origin, especially grain and grain products such as flours, meals, breakfast foods, stock and poultry feeds, copra, nut meats, candies and dried fruits.

The sawtoothed grain beetle has been recorded from alfalfa seed, barley, breakfast cereals, cereal rat baits, corn, cornmeal, corn starch, flour, macaroni, milo, mixed feeds, oats, popcorn used as a packaging material, rice, shuffle board wax and powdered hand soap containing cornmeal, wheat and wheat bran. It has also been found in spices, herbs, nutmeats, dried fruits, birdseed, dog food, graham crackers and is very common in stored grain.

The adults live, on an average, six to ten months, but some adults may live as long as three years. The female beetle lays 43 to 285 eggs. She drops them loosely among the foodstuff or tucks them into a crevice in a kernel of grain. The small, slender, white eggs hatch in three to five days.

The emerging larvae do not stay within a single grain but crawl about actively and feed. During summer, they become fully grown in about two weeks. The mature larvae then construct delicate, cocoon-like coverings by joining together small grains or fragments of foodstuffs with a sticky secretion. Within these cells, the larvae change to the pupal stage, which lasts about one week. In the summer the developmental period from egg to adult is four weeks.

Control Considerations

1. In groceries or warehouses, locate infested materials and remove/destroy them.
2. For small amounts of infested products, you can use heat (140 degrees for 20 to 30 minutes) or cold (freezing the product for a few days).
3. Properly labeled residual insecticides may be of help in controlling adults that are outside of the infested food products.
4. Maintain product off the floor at cool temperatures below 65°F.

Merchant Grain Beetle (*Oryzaephilus mercator*)

The merchant grain beetle is often confused with the sawtoothed grain beetle. It is less commonly found in grain than the sawtoothed grain beetle and appears to prefer oilseed products, including nuts. Cereal products are more likely to be infested with this insect than the grain itself.

In the merchant grain beetle, the eye diameter is larger than the temple region behind the eye and the head is rectangular. The sawtoothed grain beetle has smaller eyes and a more triangular head. The merchant grain beetle is also slightly larger and is a darker brown than the sawtoothed grain beetle. The habits and development of the two insect species are similar, but the merchant grain beetle lays only one-half to two-thirds as many eggs. In addition, the merchant grain beetle can fly, but the sawtoothed grain beetle cannot. Control of the merchant grain beetle would be the same as the sawtoothed grain beetle.

Foreign Grain Beetle (*Ahasverus advena*)

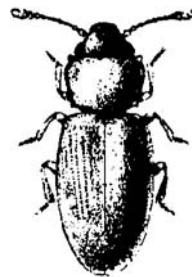


Figure 12. Foreign Grain Beetle.

This insect is placed in the same family as the sawtoothed and merchant grain beetles (but doesn't have the "saw teeth" along the margins of the thorax). Usually it is found in large numbers only when the infested product(s) is mildewed or moldy. In fact, they can feed on pure cultures of mold.

Females lay eggs singly or in clusters and under favorable conditions, the eggs hatch in about 4 days. The larvae may complete four or five molts, and the entire larval stage ranges from 11 to 19 days. Its pupation lasts three to five days, and the life cycle from egg lay to adult averages 22 1/2 days. The insect tends to do its best work and develop fastest and healthier at temperatures at 80 degrees or above and 75% relative humidity or above. Reports indicate that females lay virtually no eggs when the relative humidity is held at 58% or below.

The foreign grain beetle may be found associated with a wide variety of products: grains, cereal products, cocoa, peanuts and other oilseeds and their products, dried fruit, herbs, spices and various roots or their products. Although some of these may serve adequately as a food for this species, when found in large

numbers, the beetles probably are developing on molds. Thus, this indicates high moisture conditions conducive to mold growth.

Control Considerations

Because the occurrence of the foreign grain beetle usually indicates high moisture conditions with mold, the best control measures are to:

1. Find and remove moldy material(s).
2. Dispose of any product in poor condition as a result of the mold.
3. Correct conditions favoring mold (e.g., water leaks, entry points, etc.). Use fans and, where practical, heat to dry the infested area(s). Note: It may take 30 to 60 days for all adults to cycle out of the area after molded material is removed.
4. Use properly labeled insecticides to help control adults that are outside the infested products.

Rusty Grain Beetle (*Cryptolestes ferugineus*)

This insect is similar in appearance and biology to the flat grain beetle (*Cryptolestes pusillus*). It is more cold-tolerant than the flat grain beetle, but it infests the same kinds of materials that the flat grain beetle infests. The rusty grain beetle is normally a secondary pest and is reported to prefer high moisture conditions and decaying products. It is also commonly stated that they are found associated with fungi (mold growth). Researchers working with stored grains in Oklahoma have reported finding rusty grain beetles in grain and other products that contain less than 10% moisture. So there may be a preference for higher moisture conditions and mold growth, but apparently they can survive and develop under other conditions.

Management measures are the same as suggested for the foreign grain beetle.

Spider Beetles

These insects are occasionally associated with stored food products. They infest warehouses and households and occur rarely in mills or other food-processing plants. In general, they are considered more of a nuisance than destructive.

Spider beetles tend to be most active at night. During daylight hours or under bright light conditions, they usually hide in dark areas (cracks and crevices or under any available material). When food products are piled in stacks, the beetle population tends to be confined to the periphery. Activity is usually greatest during falling temperatures.

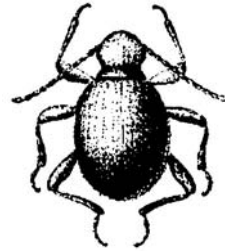


Figure 13. Spider Beetle.

Spider beetles develop slowly, the shortest life cycle being about eight weeks. The egg stage may extend from eight to 16 days. Normally there are three larval molts, and the larval development is highly variable. Under favorable conditions, spider beetle adults are long-lived (some reported for 6 months up to 2 years under moist conditions).

Temperature is the most critical factor that determines the extent of population increase. Maximum temperature is about 86 degrees F. but optimum is about 77 degrees. They usually die quickly as temperatures reach over 93 degrees F. Most species tend to reproduce and develop best between 50 and 90% R.H.

Spider beetles are mainly scavengers on plant and animal substances, but they can readily transfer their feeding to processed foods. Early studies found the beetles associated with nests of birds, insects or other animals where they were feeding on animal excrement, feathers, hairs and debris.

Generally, the most serious damage caused by spider beetles is not the amount of food consumed but in contamination from frass, body fragments and silk deposited as they wander about walls and ceiling. Larval feeding on grain is readily distinguished because the larvae eat the brancoat of the kernels unevenly. Feeding larvae secrete silken threads that incorporate fecal particles and tend to surround themselves. Older larvae tend to wander in search of a sites to form their cocoons in which to pupate. During this period, they may chew holes in textiles and

containers of linen, cellophane, plastic and cardboard. The adults do not cause this type of damage, but they may deposit their eggs through the meshes of bags. Food containers may become covered by masses of silk cocoons. The most common damage, from large populations, occurs to foods stored over long periods in dark, damp areas (68 to 73 degrees F).

Control Considerations

1. All foods should be inspected before their entry into a warehouse or household.
2. Insure that oldest products are moved first, as long storage encourages infestations.
3. Insure that are stock is piled or in racks that facilitate inspection and treatment.
4. Eliminate or seal all cracks and crevices that provide hiding places for beetles and pupation sites for larvae.
5. Search for and destroy all animal nests in or close to the premises (also eliminate animal excrement around the premises (e.g., pets, rodents, birds, etc.).
6. Apply approved residual insecticides to warehouse before stacking sacks or other food containers, and fumigate when necessary. Treat all cracks and crevices that are not sealed.

Warehouse Beetle (*Trogoderma variabile*)

Adult warehouse beetles are oval and black with variable patterns of reddish-brown blotches, and have a fine hairy covering. They range in size from 1/10 to 1/6 inch (2.4 to 4.4 mm), and the females are larger than the males. Warehouse beetles have the ability to fly.

Adults of the warehouse beetle have an average life span of 14 days. Females lay on average 38 eggs, but can lay as many as 94 eggs in one day. Most eggs are laid during the first three or four days of life. The life cycle of the warehouse beetle is about 45 days with egg incubation lasting seven (7) days, larval development 34 days and pupal development four (4) days.

The warehouse beetle is commonly found in such stored foods as almond meats, Austrian

peas, barley, beans, breakfast cereals, cake mixes, dried chili pepper, cocoa, cookies, copra, corn, corn meal, powdered chicken soup, dried peaches, egg noodles, dried figs, flour, fudge mixes, garbanzos, hominy grits, macaroni, oats, peanuts, pecans, pistachio nuts, potato chips, powdered milk, powdered puddings, raisins, rice, rye, soybeans, spaghetti, spices, tapioca, tortillas, walnut meats, wheat, wild rice and numerous other kinds of stored seeds.

Control Considerations

1. Sanitation is important, especially the removal of food residues which may be nutritious and serve as a source of insects that can infest foods or grain.
2. For processed foods, dog food, cereals, etc., dispose of infested materials.
3. Freezing or heating may be used to disinfect materials.
4. Appropriate spray and fumigation treatments may be used.

Other Dermestid Beetles (*Trogoderma* species)

There are several different Dermestid spp. that have characteristic oval-shaped bodies, including the black carpet beetle and the Khapra beetle. Distinguishing characteristics between species are difficult to find. An expert is needed to tell the differences.

Dermestid spp. larvae are tapered with their head at the large end. Prominent bristles or hairs are often found at the pointed end of the larvae. They feed in waste grain, grain dust, flour, powdered milk, candy, dehydrated soup, cigarettes, woolen products, furs, feathers and hair. Infestations are common in old boxes of clothes, overstuffed furniture, woolen carpets and piano felt. When these insects are present their cast larval skins can usually be found in or nearby the commodity. Often the presence of adults in an area may be the first sign of an infestation.

Control of dermestids in food products should be the same for other food-infesting beetles. In fabrics, prevention by sealing fabrics correctly and storage in tight containers with moth crystals is an important part of control.

Cockroaches

Cockroaches are the most abundant and troublesome pests in many buildings. They contaminate product with their droppings, their bodies and the bacteria they carry. Cockroaches can carry organisms that can cause diarrhea, dysentery, cholera and many strains of *Salmonella* and *Staphylococcus* bacteria known to cause food poisoning.

Each species of cockroach varies somewhat in their appearance and habits. However, all cockroaches have the same basic characteristics. Their bodies are flattened from top to bottom and vary from tan to chestnut brown to black. When they are at rest, the head is flexed downward and backward under a shield like pronotum. They have one pair of long filamentous antennae or "feelers," large compound eyes and chewing mouthparts.

Cockroaches hide during the daylight hours in cracks and crevices in walls, doorframes, equipment, furniture, secure places in bathrooms, utility closets, steam tunnels, animal houses, basements and sewers. They are highly gregarious and nocturnal in habit. Because of their nighttime activity, their feeding habits are seldom observed.

Cockroaches are general feeders, consuming most of the food man eats, especially the carbohydrates. They discharge liquids from their mouth and thoracic glands, implanting a musky odor to food and heavily infested rooms. Their appetite includes a taste for glue, paste, the sizing in book covers and pages, excrement and sputum. A high level of sanitation will reduce the number of cockroaches, but not eradicate them.

Cockroaches have gradual metamorphosis and lay their eggs in a case called an *ootheca*. Each cockroach type has a different shaped ootheca that can be used for identifying the type of cockroach present

When the nymphs hatch, they are white but quickly turn brownish or black depending on the type of cockroach. The nymphs will not have wings but look like small cockroaches. As the nymphs grow they will shed their *exoskeleton* or skin. The shed skin is called a *cast skin*. This shedding will be done at each nymphal growth

stage until the nymph is an adult. Once an adult, the cockroach has reached its largest size. Males mature quicker than females.

When cockroaches of various sizes of the same species are seen during an inspection, this is an indication of a well-established cockroach colony. When making surveys, trained inspectors frequently note these three signs of cockroach infestation: cast cockroach skins, egg cases and stains or excretion of cockroaches. Excreta of the larger adults are almost as large as small mouse droppings but differ in having six lengthwise ridges. When cockroach infestations are heavy, people can detect a characteristic must odor.

Identification of Cockroaches

There are about 57 species of cockroaches in the United States. However, only two small and two large species are commonly found in buildings and homes in Arkansas. These are the German cockroach, the Brown-banded cockroach, the Oriental cockroach and the American cockroach. Characteristics that distinguish these four species are discussed below.

German Cockroach (*Blattella germanica*)

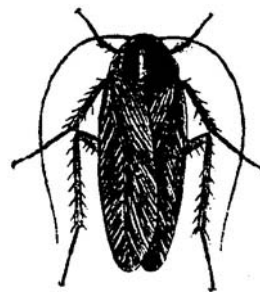


Figure 14.
German Cockroach.

German cockroaches are light brown (tawny) and easily identified by having two parallel black streaks on their back just behind their head. They are about 1/2 inch long when mature adults. Considered the most common household insect pest, they usually thrive in cooking areas, as they prefer heat and moisture. Females carry their egg capsule until hatching time. Four to six egg capsules are produced per female cockroach with 30 to 40 eggs per capsule.

American Cockroach (*Periplaneta americana*)

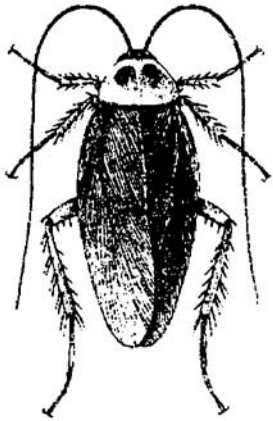


Figure 15.
American Cockroach.

When mature the American cockroach is large (1 1/2 inches) and reddish brown. These cosmopolitan cockroaches have fully developed wings that extend to or beyond their abdomen. The shield like band behind the head has a yellowish edge. Females produce reddish-brown to black capsules containing 14 to 16 eggs. They prefer basements (near pipes and plumbing fixtures) and steam heat tunnels or warm sewers. They feed on a variety of foods, but can survive without food for 2 to 3 months as adults.

Oriental Cockroach (*Blatta orientalis*)

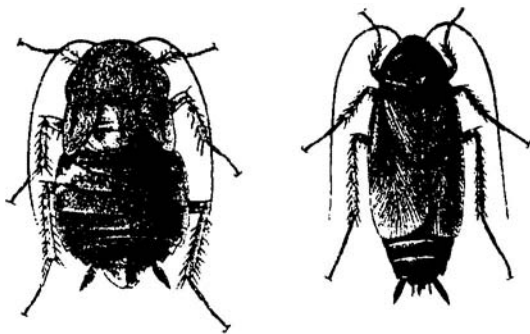


Figure 16. Oriental Cockroach, Female (l), Male (r).

The Oriental cockroach is dark brown to black and about 1 inch long when an adult. Females have small rudimentary wings while those of the male cover 3/4 of the abdomen. Each female produces eight capsules containing about 16 eggs. They feed on all kinds of filth, rubbish and other decaying matter and prefer to congregate in dark secluded areas, such as crawl spaces, basements and water drains. Note: many lay people call this roach a "waterbug."

Brown-banded Cockroach (*Supella longipalpa*)

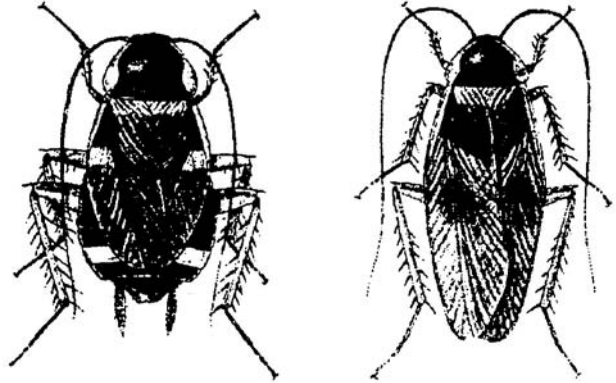


Figure 17. Brown-banded Cockroach, Female (l), Male (r).

Brown-banded cockroaches are small (1/2 inch) adults. They are light brown and readily distinguished by two lighter-colored transverse bands across the base of the wings and abdomen. It is important to identify them correctly since they are generally found high on walls or on ceilings in protected areas. They also frequent electrical appliances. Although they feed on almost anything, they seem to prefer starchy foods. Female brown-banded cockroaches produce an average of 15 egg capsules with each containing 10 to 18 yellow to red-brown eggs.

Other cockroach species infest buildings in other areas of the country. Some of these are very similar in appearance to those described above but differ in their habits. As a result, proper identification is essential to control. Contact local experts for information on other species that may be important in your area.

Apply insecticides as crack and crevice or spot treatments to places where the cockroaches hide. Label directions of residual pesticides permit only crack and crevice treatment to be used in commercial food handling areas. Dusts can sometimes be blown into places difficult to reach with spray. Use ULV (ultra low volume) and aerosol application of contact sprays and flushing agents to supplement residual sprays and dusts. Use them alone where the label prohibits use of residual insecticides.

The removal of food and water sources and destruction of breeding places is essential in obtaining satisfactory cockroach control.

Flies

Flies have one pair of wings (two wings) as adults. Flies feed by lapping and sucking up food with their sponge-like mouth. Flies actually release enzymes onto their food and the enzymes dissolve the food to the point where the fly can “sop” the food up with its mouthparts. Most any organic matter can be a food source for flies. Flies undergo complete metamorphosis: egg, larva, pupa and adult. Like the larvae of weevils, fly larvae have no legs; however, fly larvae differ in that their head is located at the small, pointed end. Fly larvae are called maggots.

The main flies that food-processing facilities may experience include the house fly, fruit fly and the green bottle fly. The house fly likes any warm moist, organic material such as garbage, manure, packinghouse wastes and other such material for egg laying. Fruit flies cause a high percentage of insect contamination of fruit and fruit products. They are especially attracted to decaying fruit and garbage. The green bottle fly prefers garbage. The blue bottle fly is similar to the green bottle fly, but prefers decaying animals for egg laying. Flies are quite prolific and can quickly become a nuisance when ample food and breeding locations are available.

Management of flies starts with sanitation in the removal of breeding locations and a good cleaning program followed by various mechanical and insecticidal controls. Wind curtains can prevent many flies from entering areas of the plant and all windows should be screened.

Ants

Normally only adult ants are seen. These ants eat many foods, but sweets and grease are preferred by the food pest ants. Most species have a winged stage once a year, and these are often mistaken for termites. They may come in from the outside where they have built their chambered nests in the ground. Their life cycle is a complete metamorphosis: egg, larva, pupa and adult.

Control of indoor or outdoor nesting ants can be accomplished by direct treatment of the nest. Locate the entries of the carpenter ant, then blow an insecticide into the nesting area. Control of other ant species is accomplished with sprays, dusts or granular insecticides directed at the nest and surrounding area. Baits may be effective as well. If you cannot locate the nest site, apply insecticides where the ants gain

entry or hide (along foundation walls, doorways, window sills, baseboards, behind built-in cabinets and furniture or beneath refrigerators and other heavy appliances).

Bees and Wasps

Bees and wasps present problems to food processing facilities when they build their nests near or on buildings, equipment or when they inhabit the surrounding areas. They pose threats to workers in plants because of their annoying threats and stings. Although they may not sting employees, they can cause employees to be injured by attempting to avoid bees or wasps.

Adult bees and wasps are robust four-winged insects that may nest in attics or between walls, or may enter buildings in the fall to hibernate. Nesting colonies build one of two main types of nest, either exposed comb or comb enclosed in a paper envelope. Honey bees present a special problem due to the risk of honey seeping through walls when the wax comb is weakened by heat. Carpenter bees may burrow a 1/2 inch diameter opening in face boards at eaves, porches and near entrances. Some species of bees and wasps will have a brood emerge continually during the warmer part of the year. These insects present a particular risk to people who are hypersensitive to stings.

Special protective clothing is needed when controlling wasps and desirable when controlling bees to protect against stings. Insecticide sprays directed into the nests work well, particularly with wasps and hornets. The sprays must be applied at night with an applicator large enough to do the job quickly without getting too close to the nest. Dusts may be blown into the nest openings of hornets and yellow jackets. For some species, baits may be available.

Other Occasional Insect Pests

Booklice/Psocids (Lepidotus and Liposceles Species)

Booklice are very short (1/16 inch) and soft bodied. Depending on the species, some psocids have wings while others are wingless. Certain psocids are called “booklice” because they are very small and resemble lice, plus they are found around books and papers stored in damp locations.



Figure 18. Booklouse.

These insects feed on microscopic molds, fungi, dead insect fragments, pollen and other starchy foods found in humid environments such as houses, warehouses, libraries and structures where green lumber is stored or used in construction. Sweating and high humidity may form in wall voids when new lumber becomes enclosed (i.e., from uncured green lumber) or in/around newly plastered areas.

Damp basements, crawl spaces, leaky and sweating plumbing, cereal, flour, bird nests, furniture stuffing of natural plant fiber, paste on book bindings, grains and similar sites/materials are areas where booklice infestations are common. They do not normally actually damage grain, but they can contaminate grains and stored food products. Although they can be a major contamination problem for mills, processing plants, storage facilities and other locations, they are considered more a nuisance and annoyance pest.

Control Considerations

1. The primary method for avoiding problems with psocids is good sanitation. Keep spillage cleaned up and store food, boxes, books and papers off the floor and in dry areas.
2. Lowering the relative humidity (R.H.) hinders development or causes death due to desiccation (drying out). Effort should be made to reduce the R.H. in rooms and buildings to less than 50 percent. Drying of infested materials and reducing the R.H. also eliminates the primary food sources such as molds and mildews.
3. All efforts should be made to prevent infestations. Infested cereals or stored foods can be discarded or supercooled in a deep freeze (up to 7 days). Books, papers or upholstered furniture can be dried in sunlight.
4. Fix all leaky plumbing, insure that the outside grade is away from the building, install a vapor barrier in the crawl space or add additional ventilation in crawl space.
5. Seal cracks in interior and exterior foundation walls and repair leaking rain gutters, downspouts, root vents and roofs.
6. Avoid accumulations of paper, books or magazines.
7. When infestations occur, ventilate and dry areas with a dehumidifier and/or fans.
8. Insecticides should only be used as a supplement to sanitation, heat/cold and drying techniques and never as the primary control procedure. Residual and space spray treatments with properly labeled materials can be employed once all other control considerations listed above have been employed if a few booklice are still found in the area.

Silverfish and Firebrats

Silverfish and firebrats are wingless insects with a characteristic flat shape, widest before the middle, and tapering to the rear. They have long antennae and three long antennae and three long tails at the end of the abdomen, giving rise to the common name “bristle tails”. They are silvery, brownish or blackish. Development from egg to adult is completed in about 12 weeks.

Often found in warehouses, silverfish or firebrats primarily cause damage to paper, book bindings, wallpaper, labels and stored foods. Silverfish are nocturnal in habit and are most frequently found in dust, label and box storage areas, file cabinets and in sinks where they have become trapped searching for water. Firebrats prefer hot, dry situations and are found more often in bakeries, boiler rooms or behind heating units.

To control this insect problem, direct sprays into cracks and crevices, dusts and bait insecticides prove to be effective.

Crickets

The house cricket is a shiny, black insect that is fond of warmth and may become a pest in processing plants, although it ordinarily lives out-of-doors. This insect develops by gradual metamorphosis. It has chewing mouthparts, long legs fitted for jumping and two pairs of wings when fully grown. The adult male produces the familiar chirping sound by scraping his outer wings together. Crickets sometimes feed upon

book bindings and labels. The cave and camel crickets often invade basements if openings are available. They are large humpbacked insects, usually with no wings, and with antennae much longer than the body. They are plant feeders and are considered nuisance pests in processing facilities. Crickets can become very numerous in the fall and are attracted to lights. Proper management of lighting will discourage them from entering buildings as the adults are active at night and readily move toward lights.

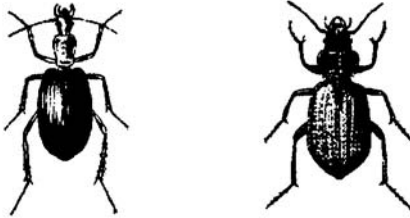


Figure 19. Slender Ground Beetle (l), Ground Beetle (r).

Ground Beetles

These nimble, soil inhabiting species occur in a wide range of sizes and colors. The smaller forms may be about 1/8 of an inch long, while the larger can be up to an inch in length. Colors vary from brown and black to red and green. Ground beetles prey upon other insects and related animals in the soil.

They may invade processing facilities, usually at windows and doors.

Ground beetles do no damage but can become a persistent nuisance where moisture is difficult to control. Removal of debris around foundations is helpful in controlling this insect. Proper management of lighting will discourage them from entering buildings, as the adults are active at night and readily fly toward lights.

Other Arthropods

Sowbugs and Pillbugs

Sowbugs and pillbugs are arthropods but not insects. They are very much alike in appearance ranging from gray to brown. Their bodies are oval in shape, about 1/2 inch in length, with the upper surface of their bodies covered by heavy segmented plates. They have seven pairs of legs and no wings.

These insects can be a pest in greenhouses, flower beds and sometimes potted plants. They can become a nuisance in damp areas (under fiber mats, pallets, rugs, etc.) sometimes feeding on improperly stored paper boxes and corrugated cartons. Removal of leaves, decaying vegetation, peat or composting materials next to or adjacent to foundations and buildings will generally aid in preventing infestation of buildings. The same control measures used for centipedes and millipedes are usually effective. A gravel barrier, as described in the section on rodent control, will assist in decreasing sowbugs and pillbugs.