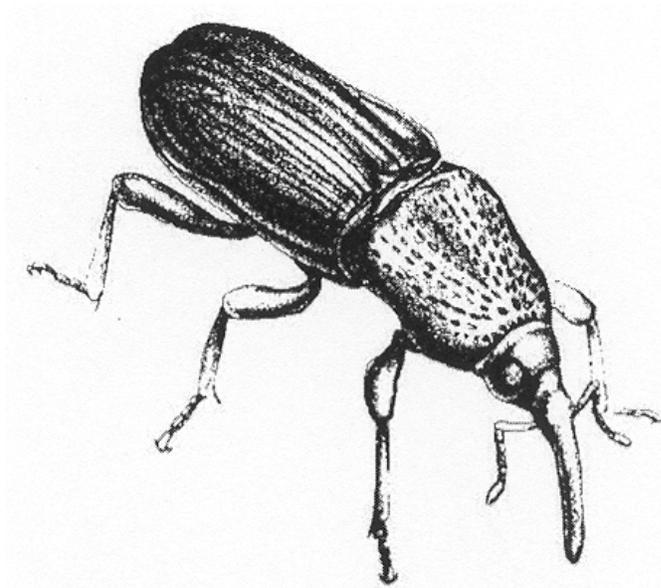

STORED GRAIN INSECTS OF WYOMING, AN INTRODUCTION

MP22



COOPERATIVE EXTENSION SERVICE
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The University of Wyoming
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STORED GRAIN INSECTS OF WYOMING, AN INTRODUCTION

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Forward

This document provides an introduction to the description and life history of stored grain insects of Wyoming. A few important stored grain insects that may invade Wyoming in the future are also reviewed. More extensive reviews on biology and management, including specific chemical controls available, should be consulted for those readers who will concentrate on this topic of pest management. Selected references on this topic are listed in the appendix (they may be borrowed from the university library, purchased from a bookstore, or obtained as listed in the reference). In addition to life history, management practices that tend to retard infestations are given in the introduction and subsequent sections. Combined with Wyoming climatic conditions, management practices that tend to block initial infestations and retard insect population increases often result in good stored grain pest management.

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STORED GRAIN INSECTS OF WYOMING, AN INTRODUCTION

INTRODUCTION

Several insects and mites can infest stored grain, whether the grain is being held in bulk in elevators and mills, in large quantities on the farm, or in small lots in the household. Most of the economic species occur principally in the warmer, more humid parts of the U.S. Low winter temperatures and hot dry summers in Wyoming usually keep insect infestations from developing to economically damaging levels in stored grains. A few have adapted to colder northern climates and may occur in Wyoming. The low relative humidity of Wyoming normally keeps these species from attaining economic status during the first season of grain storage because mature grain is usually too dry for insect attack. The problems associated with insect infestations may be partly a consequence of adverse weather conditions -- an abnormally wet harvest season or other unusual circumstances may leave enough moisture in the grain to make it susceptible to insect injury. Inappropriate cultural practices, such as contamination of storage containers with infested old grain and storage of grain with elevated moisture content, also can be significant factors contributing to stored grain problems. Overall, climatic conditions in Wyoming are often an impediment to stored grain pests and in combination with good cultural practices, pest problems which are common in other parts of the U.S. can often be avoided in Wyoming.

On the farm, insect infestations of stored grain often start at harvest. Broken kernels are particularly prone to insect attack by species that feed outside the kernel. Preventative measures include harvesting the grain as dry as possible and adjusting combines to minimize cracked kernels. Equipment should be kept clean of grain residue to prevent contamination of newly harvested grain.

In storage facilities, heavy infestations may develop where the grain is sufficiently moist, provided there is a local source of the pests.

The grain also may react with moisture to produce heat, which in turn aids survival of stored grain pests during low winter temperatures. Problems with stored grain pests can usually be traced back to a source of moisture, whether it is in the grain itself or from an outside source. Outside sources of moisture may include leaking roofs, poor surface drainage, or underground seepage. Good management practices that reduce excess moisture are important components of stored grain pest management. Good sanitation, such as the removal of old, damaged and possibly infested grain, should always be practiced before storing new grain.

Properly maintained storage structures aid in restricting insect contamination and permitting necessary insecticide treatment. The storage structure should prevent spills and protect the grain from precipitation, soil moisture and wind damage. The facility also should be protected against animal pests and allow for insecticide treatment to prevent or control infestation. Last, the structure should allow for easy cleaning and grain inspection. Options for chemical control of insects in stored grain include residual sprays of the bins before grain is stored, protective treatments during the binning operation, and application of insecticide to the grain surface after it is stored.

A considerable number of wasps, flies, mites, and other beneficial insects and mites may be found in long-established stored grain infestations. These beneficials may attack various development stages of pest species. Unfortunately these insects and mites may remain in the stored products after they have killed the pest. Therefore, most parasites and predators would be considered a contaminant in the stored grain and grain products and are often considered undesirable.

INSECTS THAT FEED OUTSIDE THE KERNEL AS IMMATURES AND ADULTS

Mealworms

The adults are black, elongate-oval beetles. Two species commonly occur in Wyoming: 1) the yellow mealworm, *Tenebrio molitor* L., adult is polished (shining) brown to black and 1/2 to 2/3 inch long (10-20 mm); and 2) the dark mealworm, *Tenebrio obscurus* F., adult is dull black (not shining) but similar in size to the yellow mealworm. The dark mealworm is a much darker yellow than the yellow mealworm. The larvae of both are long, measuring 1 to 1.25 inches long (20-25 mm). The larvae are slender, clearly segmented, and have a characteristic "hard shelled" texture of body (Fig. 1). The body tapers to a point posteriorly. Both species have a slight side-to-side worm-like movement when crawling.

Winter is passed in the late larval stage. Pupation (in unheated sites) occurs in the spring and adults emerge in late spring or early summer. Eggs are minute, white, and deposited singly on grain and grain products. Since eggs are covered with a sticky substance when deposited, foodstuff particles tend to adhere to them. Yellow mealworm larvae may require

9 months to mature to adults. Dark mealworm larvae may reach the adult stage in about 3 months during the summer months. Developmental time may be lengthened to two full seasons in highly unfavorable conditions. Infestations developing indoors (heated location) may result in yellow mealworm adults appearing much earlier, in November or December, than under normal conditions. Dark mealworm adults may begin to appear in late January in heated locations. Adults live 2 to 3 months and females produce 250 to 300 eggs (yellow mealworm) or 450 to 500 eggs (dark mealworm).

Mealworms are scavengers and are attracted to spilled or spoiled grain and grain products. They live in accumulations of grain in out-of-the-way locations in mills and elevators; around and under sacks of feeds and grains in warehouses and feed stores; and in damp grain or grain products in or under bins and storage sheds. They also may be found in other farm and home locations, such as chicken house litter, bird cages, and various grain product spill areas. To prevent infestation, all old grain should be removed from inside

the bin and surrounding area; these remnants should be destroyed. Fully developed larvae leave the feeding site and wander in search of a pupation place. The presence of masses of mature crawling larvae frequently causes more concern than does their feeding damage. The larvae may crawl into almost any type of container, causing the contents to be classified as contaminated, even though they may not be feeding on the contents.

Cadelle

The cadelle beetle is a common pest of stored grain on the farm where grain is stored in wooden structures. In modern elevators and mills where wooden holding structures have been eliminated, these beetles are not abundant. The adult is black, about 1/3 inch long (8 mm), and flattened. Its shape is characteristic: the neck-like constriction between the back of the prothorax and the base of the wings gives the beetle the appearance of having two distinctive blocky body segments. Several longitudinal grooves appear on the wing covers and the last five antennal segments are enlarged (Fig. 3). Larvae grow to about 3/4 inch long (20 mm). Larvae are fleshy white, and have a black head and two black curved spines on the posterior end (Fig. 3.) Adults may live 2 years, and 1,000 or more eggs may be laid per female. Eggs hatch in 1 to 2 weeks. The total egg to adult development is completed in 2 or more months, depending upon temperature and humidity.

Adults and larvae feed on grain and various grain products. They are commonly found in wooden structures because adults and larvae burrow into the wood parts of bins, boxcars, mills, and elevators. These burrow holes also serve as an excellent harborage for many smaller insect pests of grain. Thus, bins which appear free of insects may be harboring various pests in the cadelle burrows. Close inspection and thorough cleaning of wooden structures is an important sanitary measure to prevent infestation of new grain. Storage bins should be kept free of old, damaged grain. These cultural practices may need to be combined with an approved residual insecticide spray, applied a minimum of two weeks before storing new grain (see labels for specific time intervals), if these insects are a recurrent problem.

Flour Beetles

This category includes a number of small beetles which do not directly attack whole stored grain. They feed upon damaged or cracked grain, brans, flours, cereal products, and pet foods in mills, elevators, granaries, and the home. The two most common species in Wyoming are the confused flour beetle, *Tribolium confusum* Duval and the saw-toothed grain beetle, *Oryzaephilus surinamensis* (L.). The adults are reddish-brown and about 1/8 inch long (3 to 5 mm) (Fig. 11). They quickly run to cover when disturbed. Other related species are similar in size and habits to these two species. Adults may live more than three years, and females may produce 300 to 400 eggs. Development (egg to adult) may be completed in 7 to 9 weeks but may require longer time periods for some species. Due to the relatively short generation time, infestations may build up rapidly when the temperature is optimal and the food supply is adequate. Multiple generations occur each year.

Adults and larvae of these beetles spread throughout mills, elevators, granaries, and homes (wherever an accumulation of grain dust, grain fragments, or grain products is found). They may contaminate milling machinery and then enter into packing material as the product is being processed. Even clean, packaged and sealed products may be infested due to the small size of the beetles. They are able to force themselves through seams and edges of many containers such as cardboard packages. These insects probably are the most widespread and persistent stored grain problem in the U.S., and many species are distributed world-wide. All old damaged grain in and around storage containers should be eliminated. After removal of damaged grain, bin wall insecticide treatment may be warranted where flour beetles are a recurrent problem. Use residual insecticide sprays to treat the inside and outside bin surfaces. Cracks, crevices, and door jams also should be treated. Sprays should be applied a minimum of two weeks but not more than two months before grain storage (the insecticide you choose must be labeled for this purpose and all label instructions must be followed).

Dermestid Beetles

These beetles are small, varying from 1/12 to 1/8 inch long (1-3 mm), oval and dark in color. The wing covers of adults have detectable short hairs when viewed with a 10-power hand lens, while larvae have longer hairs (Fig. 6). Adults and larvae are injurious to grains and grain products. Infestations are often first noticed by the presence of cast larval skins that accumulate on the surface of grain. One generation can be completed in 25 to 55 days. If food is not available, larvae can live extended periods.

Occasionally minor problems with native dermestids will be encountered in Wyoming. Good sanitation is often adequate in preventing infestations of these beetles. The khapra beetle, *Trogoderma granarium* Everts, is a dermestid recently established in the U.S. which attacks grain in elevators, mills and warehouses. Populations increase rapidly where it is known to occur. The khapra beetle has not been detected in Wyoming. Management options for flour beetles, discussed in the previous section, aid in the control of dermestid beetles.

Spider Beetles

These long-legged, small, flightless beetles have a small head and thorax and a larger, rounded or globular body. They superficially resemble small spiders (Fig. 2). Several species have a hairy covering over the body, but others are hairless and shining brown. Several species including *Ptinus fur* L., may be found occasionally infesting stored grain in bins, elevators, and warehouses. *Ptinus fur* has a reddish-brown body covered with yellow hairs and is about 1/8 inch in length (2-4 mm).

Development is relatively slow, with only one generation per year in Wyoming. Eggs are laid loose in the foodstuff. Larvae are very small, grub-like, and frequently live and feed within small globular cases. Infestations build up slowly except in protected areas with a good food supply.

Spider beetles may attack stored grain, but usually they are scavengers of spilled grain and litter. They

may be found in warehouses, heated basements where trash and food scraps are stored or accumulate, and occasionally in granaries and elevators. They are known to feed on whole grains, grain products, animal skins, feathers, dead insects, and manure. Overall, spider beetles are of little importance throughout the U.S. but may occur in high numbers in isolated situations. Good sanitation is often adequate to prevent infestations of these beetles.

Indian Meal Moth

The Indian meal moth, *Plodia interpunctella* (Hbner) is about 3/8 inch in length (10 mm). Its wings are folded on top of its back when the moth is at rest; at this time conspicuous dark and light colored bands can be seen on the wings. Each female produces about 200 eggs which are laid loosely on the surface of grain. Newly hatched larvae are dirty white, pinkish, or light green in color and are near naked (only with a few hairs). Full size larvae are about 1/2 inch long (10-12 mm) (Fig. 9).

The larvae are common and are severe pests of stored grain and grain products. Larvae feed and develop on ear corn, shelled corn, and virtually every other type of stored grain. They are able to work their way through sacking material, thereby gaining access to the product in the bag. Larvae also feed on dry cereal products. Damage by the larvae is due partly to their feeding on the grain directly and partly to their habit of spinning silk and using this silk to web food particles together. The larvae are usually found in this webbing, but they will often wander out of their webbing when they are ready to pupate. The webbing material will typically be found near the surface of grain stored in containers because the female lays its eggs on the surface layer of the grain.

Removal and destruction of infested grain will aid

in preventing reinfestation of new grain. The moth prefers to oviposit on moist grain; therefore, storing grain at the appropriate low moisture content will aid in preventing infestations. The microbe, *Bacillus thuringiensis* var. *kurstaki*, provides slow but often adequate control of larvae. The *B. thuringiensis* formulation should be applied to the top four meters of stored grain. Also, pheromone traps are available for detecting the moth in storage facilities.

Mediterranean Flour Moth

The Mediterranean flour moth, *Anagasta kuehniella* (Zell.), is primarily a pest of mills but also will develop in grain products accumulated in other locations. Three other closely related species can be problematic in other parts of the country and could eventually become established in Wyoming. The adult is about 1 inch in length (25 mm) and has grayish front wings with wavy black lines that lay over the back when the adult is at rest. Full grown larvae are about 1/2 inch long (10-15 mm), are white to pink in color, and are nearly naked (with only a few hairs) (Fig. 8). Egg to adult development requires 8 or 9 weeks under normal summer conditions.

Females usually fastened eggs with a sticky material onto food material such as flour. The female may lay 100 to 300 eggs. Larvae spin a silken tube and feed within this webbing. The webbing may clog machinery, and it is this activity which may be the most disruptive to the operation of a mill or elevator. Equipment should be cleaned thoroughly to prevent damaging infestations. Extensive webbing may also be found in various other sites of infestation, such as granaries and corn cribs. The immature stages may be packaged with grain products; therefore, this insect is considered a significant pest of flour and flour products.

INSECTS THAT TEND TO FEED INSIDE THE KERNEL AS IMMATURES

Weevils

The most important economic weevils are the rice weevil, *Sitophilus oryzae* (L.), in the warmer, more southern areas and the granary weevil, *Sitophilus granaris* (L.), in the northern states. The adults are about 1/8 inch long (3 mm), are reddish-brown to black, and the head is prolonged outward and down (snout beetles). Chewing mouthparts are located on the apex of the snout.

The rice weevil is a strong flier and has four light colored spots on the wing covers. Its thorax is covered with shallow punctures, and the wing covers have rows of small shallow punctures. The granary weevil cannot fly and is uniformly colored. Its thorax has numerous deep punctures, and the wing covers have longitudinal grooves (Fig. 10).

Rice weevil females can start an infestation by laying eggs inside the maturing kernels before harvest. In the northern part of its range, it remains in or around storage facilities, infesting and reinfesting stored, spilled, or waste grain. The granary weevil, unable to fly, can start new infestations only by crawling or by being carried by man to new supplies of food grain. Characteristic of both species, female weevils chew

small holes in kernels of grain and deposit an egg in each hole. The egg is held in place by a "plug" of gelatinous material secreted by the female after each egg is deposited. Each female may lay from 300 to 400 eggs. The white, legless, grub-like larva hollows out the interior of the seed as it feeds (Fig. 10). The larva develops to the adult stage inside the kernel. One generation, egg to adult, is completed in about 27 to 40 days, depending upon temperature. Adults chew out of the kernel and will continue to feed on the surface of the grain. In areas where weevils occur, grain should be inspected at least monthly. Insecticide treatment may be necessary where temperatures result in development of multiple generations of the weevils. In cool temperatures, <60 F, there is less likelihood of development of damaging infestations. Once infestations are well established remedial chemical control is difficult because the larvae are protected inside the whole grain. An exception to their habit of feeding inside grain is their ability to feed on solidified flour products such as macaroni.

Grain Borers

The lesser grain borer, *Rhyzopertha dominica* (F.),

is found in other areas of the U.S. but may become established in Wyoming in the future. This beetle is about 1/8 inch long (3 mm), shining dark brown to black, and has a rounded, bulbous thorax. The head is small relative to the size of the prothorax and is partly concealed by the prothorax when viewed from above (Fig. 5).

Female beetles can lay from 300 to 500 eggs. The eggs are dropped loose in the grain. Small, white, grub-like larvae hatch and initially feed on bits and pieces of grain (Fig. 10). Development may be completed within a grain or in accumulations of debris. Larvae developing inside grain will push dust-like excrement out of the kernel. The "dust" has a distinctive sweet, musty odor and is often the first detected indicator of an infestation. If larvae mature inside the kernel, adults will chew out of the kernel and continue to feed on the outside surface. One generation, egg to adult, is completed in about one month. Both adults and larvae cause severe loss in stored grains. The adults are strong fliers and spread rapidly from one storage container to another. Sanitary practices aimed at disposal of old, damaged and possibly infested grain will aid in preventing infestations of newly stored grain.

Angoumois Grain Moth

The Angoumois grain moth, *Sitotroga cerealella* (Olivier), is not currently established in Wyoming but is found elsewhere in the U.S. The moth is about 1/2 inch long (8-10 mm) and light tan in color. Its wings are narrow and fringed with long "hair" (Fig. 7). In the field, females fly to developing grain and lay eggs on the milk-stage kernels.

Once the grain is harvested and in storage, the moths are unable to penetrate below the surface, hence infestations that start in a storage facility are limited to the surface layer of grain. Each female produces from 40 to 100 eggs which hatch into minute white larvae. The larvae bore into individual kernels and complete the entire life cycle inside one grain of wheat or corn.

Acknowledgment

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Appendix

Selected References

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Before pupating, the larva chews a small circle inside the kernel, leaving only a thin outer layer of the kernel. When the adult emerges, it pushes itself out of the kernel through this weakened outer layer. Field-infested grain is a source of initial infestations in storage facilities. Adults emerging out of this grain will reinfest the surface layer of grain once in storage. Development in field grain is rapid (egg to adult development is completed in five weeks), and infestations build up rapidly. Before or between crops, the insect continues to breed in other grain in barns, granaries, corn cribs, and waste grain in the field or around straw stacks. Since whole grain is needed for larval development, good sanitary practices, including removal or destruction of old grain, will greatly inhibit the development of large infestations. The microbe, *Bacillus thuringiensis*, will not be very effective in controlling the larvae because larval development occurs mostly inside the kernel.

MISCELLANEOUS

Grain Mites

The grain mite, *Acarus siro* L., and related species are minute crawling arthropods (less than 1/16 inch [2 mm] in length) which may build tremendous populations in damp, moldy grain or grain products (Fig. 12). They feed on a wide variety of plant and animal matter. They do not bite people but can be a nuisance to persons handling infested grain. Grain mites do not cause serious damage to grain under normal storage conditions in Wyoming.

Females produce viable eggs without males, and each female may lay 100 or more eggs. The young are similar to the adults (8 legs, long filamentous hairs on legs and body) and grow rapidly. The egg to adult period is about 3 weeks in summer.

U.S. Department of Agriculture, Federal Grain Inspection Service. 1991. Inspecting grain, practical procedures for grain handlers. U.S. Department of Agriculture, Federal Grain Inspection Service, 78 pp (provides information on procedures for conducting commercial grain inspections, copies can be purchased from the Superintendent of documents, Government printing office, Washington D.C. 20402).

Figure Captions:

Fig. 1. Yellow mealworm adult, pupa and larvae.

Fig. 2. Spider beetle adults, pupa and larva.

Fig. 3. Cadelle beetle adult and larva.

Fig. 4. Sawtoothed grain beetle adult, pupa and larva.

Fig. 5. Grain borer adult, pupa and larva.

Fig. 6. Dermestid beetle adult and larva.

Fig. 7. Angoumois grain moth adult, larva and pupa.

Fig. 8. Mediterranean flour moth adult, pupa and larva.

Fig. 9. Indian mealmoth adult and larva.

Fig. 10. (Top left) Granary weevil. (Bottom left) Rice weevil. (Top right) Lateral view of rice weevil. (Middle and bottom right) pupae and larvae of granary weevil.

Fig. 11. Confused flour beetle adult, pupa and larva.

Fig. 12 Grain mites (greatly enlarged).

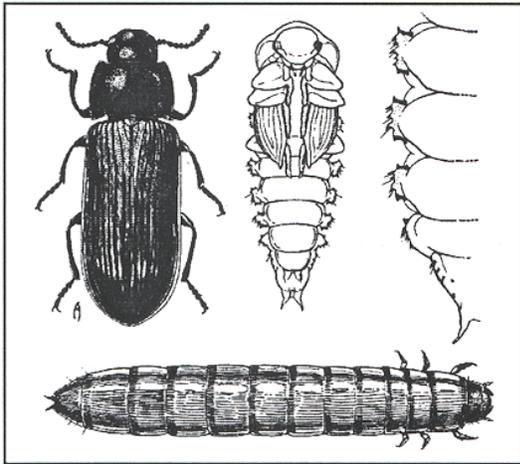


Figure 1. Yellow mealworm adult, pupa and larva.

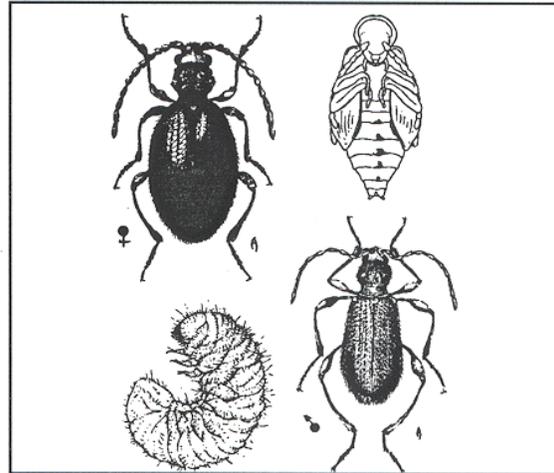


Figure 2. Spider beetle adults, pupa and larva.

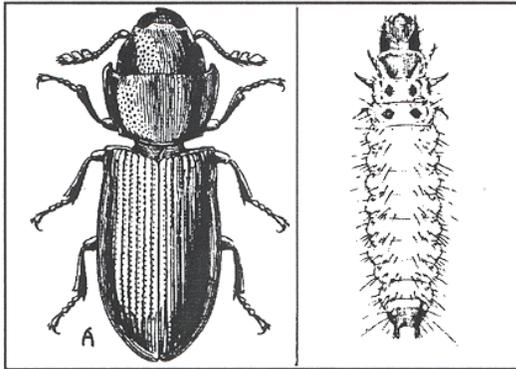


Figure 3. Cadelle beetle adult and larva.

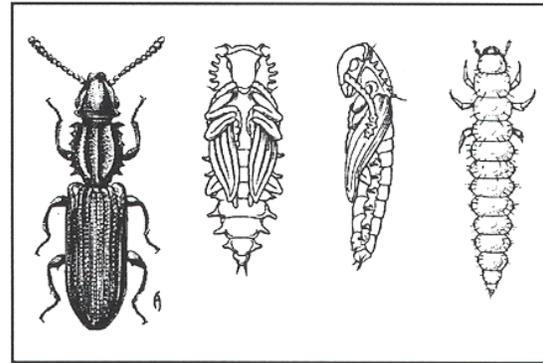


Figure 4. Sawtoothed grain beetle adult, pupa and larva.

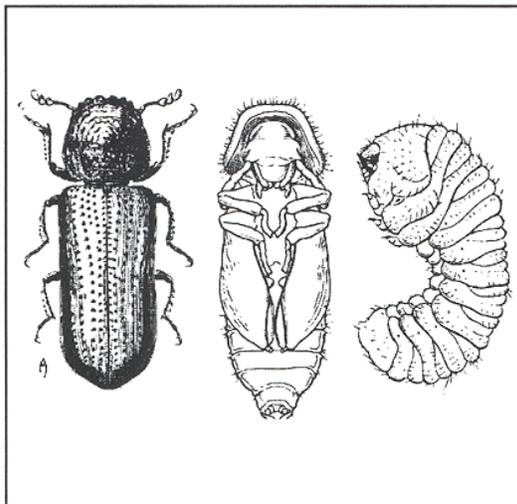


Figure 5. Grain borer adult, pupa and larva.

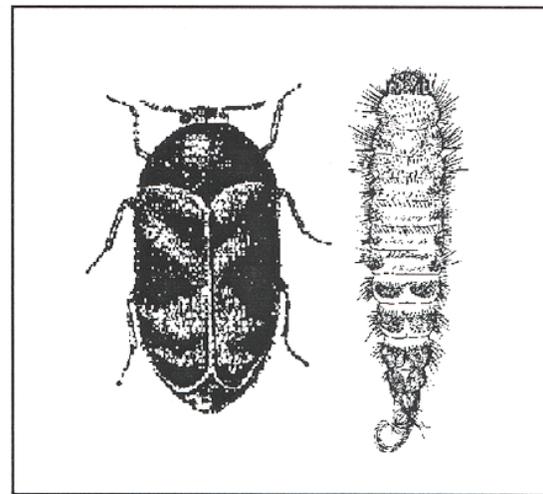


Figure 6. Dermestid beetle adult and larva.

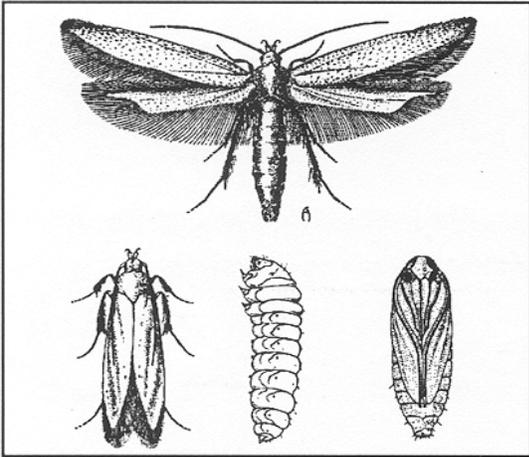


Figure 7. Angoumois grain moth adult, larva and pupa.

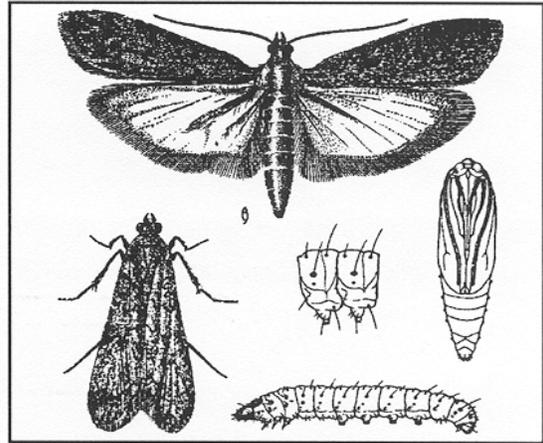


Figure 8. Mediterranean flour moth adult, pupa and larva.



Figure 9. Indian mealmoth adult and larva.

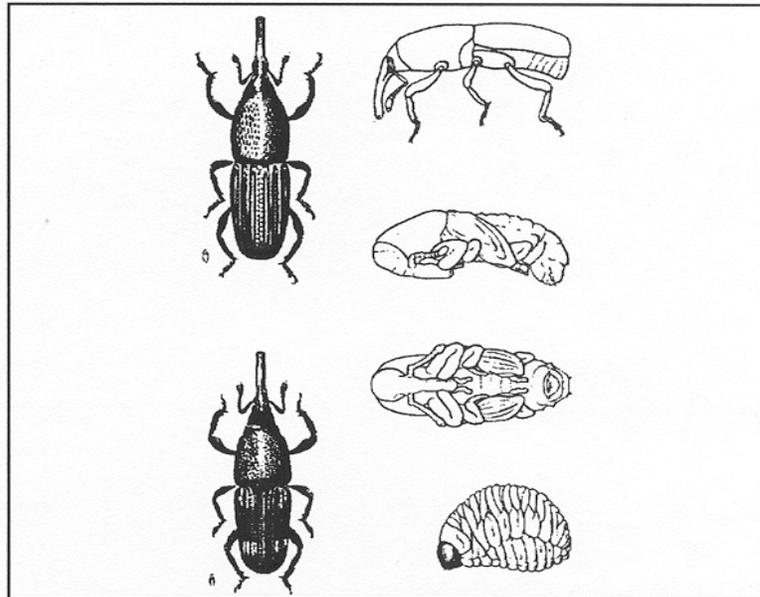


Figure 10. (Top left) Granary weevil. (Bottom left) Rice weevil. (Top right) Lateral view of rice weevil. (Middle and bottom right) pupae and larvae of granary weevil.

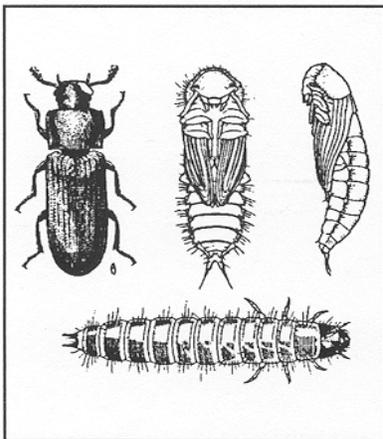


Figure 11. Confused flour beetle adult, pupa and larva.

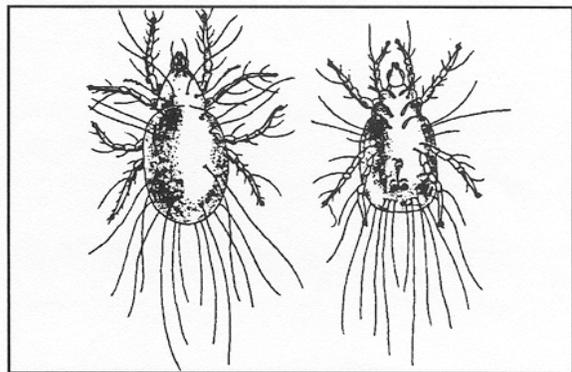


Figure 12. Grain mites (greatly enlarged).

