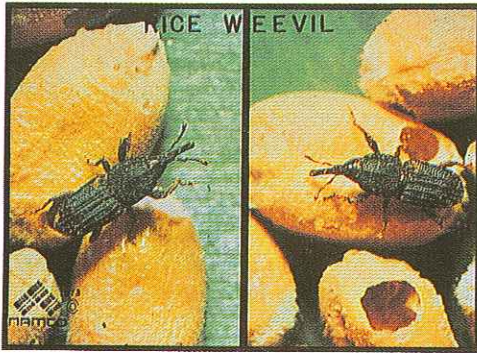


Stored Grain and Cereal Product Insect Pests

Van Walters and Rogers



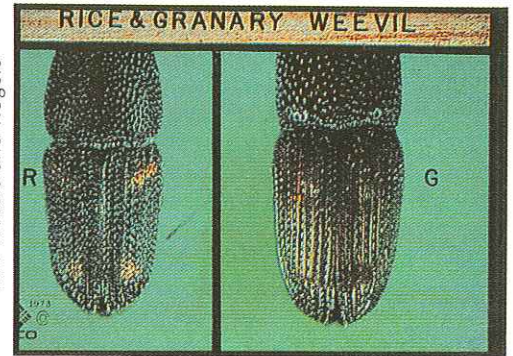
1. Rice weevil adults on damaged wheat kernels (*Sitophilus oryzae*)

University of Minnesota



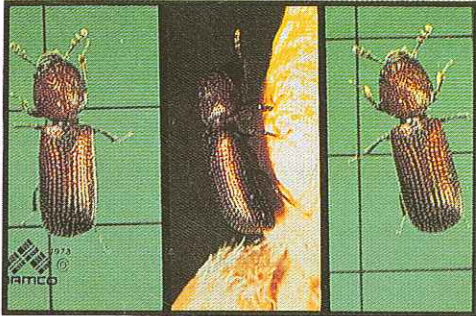
2. Granary weevil adults on wheat kernels (*Sitophilus granarius*)

Van Walters and Rogers



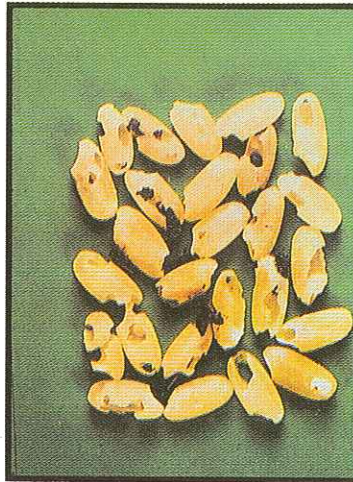
3. Rice and granary weevil identification characteristics (*Sitophilus oryzae* and *Sitophilus granarius*)

Van Walters and Rogers

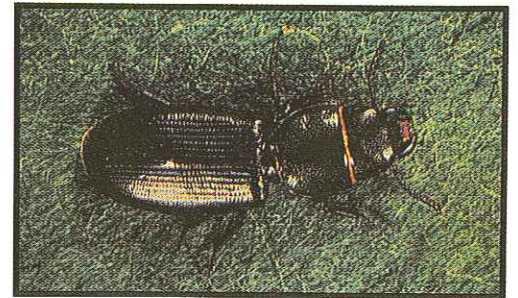


4. Lesser grain borer adults (*Rhyzopertha dominica*)

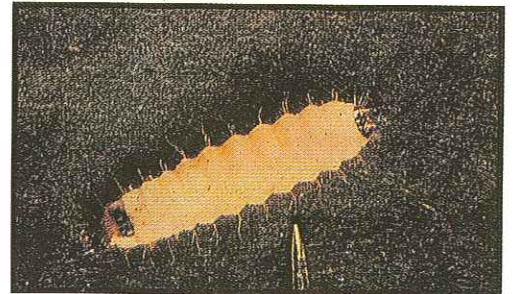
U.S. Dept. of Agriculture



5. Wheat kernels damaged by lesser grain borers (*Rhyzopertha dominica*)



6. Adult cadelle beetle (*Tenebroides mauritanicus*)



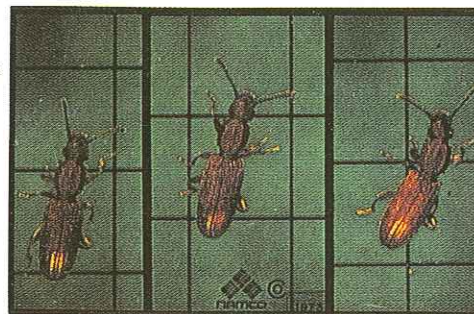
7. Cadelle beetle larva (*Tenebroides mauritanicus*)

University of Minnesota



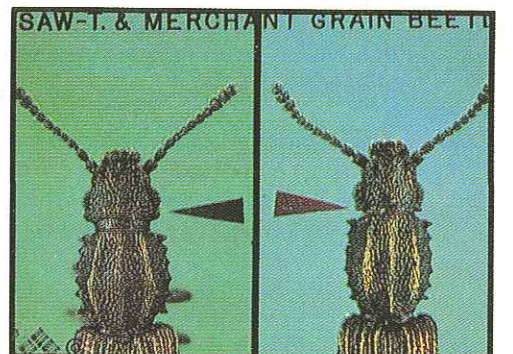
8. Larger black flour beetle adults on shelled corn (*Cynaues angustus*)

Van Walters and Rogers



9. Saw-toothed grain beetle adults (*Oryzaephilus surinamensis*)

Van Walters and Rogers

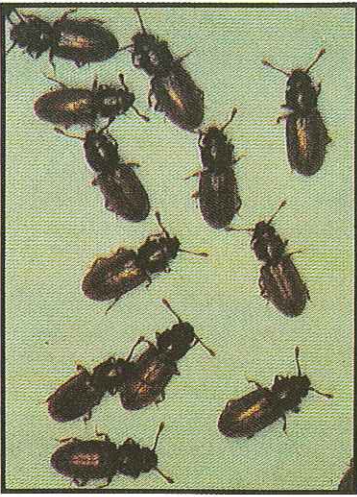


10. Saw-toothed and merchant grain beetle identification characteristics (*Oryzaephilus surinamensis* and *Oryzaephilus mercator*)

1. **The rice weevil, *Sitophilus oryzae***, is a snout beetle which varies in size and color (reddish brown to black) with two lighter colored spots on each wing cover. Fully developed wings allow this weevil to infest rice, corn, wheat and other grains in many areas. The thorax of the adult weevil is pitted with irregularly shaped punctures. Adults live 4-5 months with the female depositing 300-400 eggs. Each egg is deposited into a small hole chewed into a kernel with the developing insect not leaving the kernel until reaching the adult stage in 26 to 45 days.
2. **The granary weevil, *Sitophilus granarius*** is a small, blackish or reddish brown snout beetle. It is similar to all weevils in having a mouth at the end of their snout. This weevil rarely exceeds 3/16" long and has no wings under the wing covers. The thorax has many longitudinal punctures. Both adults and larvae feed on a wide variety of grains. The adult females live 7 to 8 months and deposit 50 to 250 eggs inside grain kernels. Development of the immatures takes 4 to 6 weeks depending primarily on temperature.
3. **Rice weevil (*S. oryzae*) and granary weevil (*S. granarius*)** identification characteristics. Please note description under pictures #1 and 2.
4. **The lesser grain borer, *Rhyzopertha dominica*** is easily distinguished from other grain pests by its slender cylindrical form and small size (1/8" long and 1/32" wide). It is dark brown or black, with a roughened surface. This borer has the head turned down under the thorax where powerful jaws allow it to chew grain kernels into a fine powder. Each female lays 300 to 500 eggs and deposits them on the kernels. After the eggs hatch the small whitish larvae crawl actively about the grain or bore directly into kernels. They complete their developmental stages within the kernels similar to the weevils. At 80°F the period from egg to adult is about 1 month.
5. **Wheat kernels damaged by lesser grain borers (*R. dominica*)**. Individual kernels are often reduced to a shell within which may be found several adult beetles. Although the larvae may prefer damaged kernels to enter, they are capable of penetrating sound kernels. Damaged kernels are often surrounded by powder produced by the borer feeding. Established infested grain often has a urine-like odor.
6. **Adult cadelle beetles (*Tenebroides mauritanicus*)** are large, elongate (1/3"), black beetles with the head and prothorax attached to the remainder of the body by a narrow joint. Adult males have more numerous finer punctures on the ventral side of the abdomen compared to the coarser, less numerous punctures of females. The cadelle is widespread throughout the world attacking stored grain during its 1- to 2-yr. lifespan. There may be three generations per year in southern U.S. with only two generations generally in the north.
7. **The cadelle, *T. mauritanicus*, larva** is easily recognized by its large fleshy size (3/4" long) with two dark horny projections on the rear end of its body. There are also black spots on the thoracic segments immediately behind the head. These larvae hatch in 1 to 2 weeks from several hundred eggs deposited by a single adult female. Depending on the temperature, larval development takes 1/2 to 1 year. The cadelle is widespread over the world and is frequently found in mills, granaries, and storehouses, where it infests flour, meal, and grain. Both the larva and adult feed on grain and have the destructive habit of going from kernel to kernel to consume the germs. They may remain hidden for months in holes bored into wooden storage structures.
8. **Larger black flour beetles (*Cybaeus angustus*)** have recently become a frequent grain pest insect in stored corn. They consume the germ of sound kernels with one larva attacking several kernels. It also infests barley and oats. The larvae feed on the germ, chewing a circular hole through the pericarp. As an adult, as shown, it is a relatively large (1/4") reddish brown to black beetle. Its life cycle from egg to adult is 4 to 10 weeks and may live for at least 1 year under favorable environmental conditions. It prefers high moisture grain.
9. **Saw-toothed grain beetles (*Oryzaephilus surinamensis*)** are one of the most common insects in stored grain and cereal products. It is a slender, flat beetle about 1/10" long. Its name is based on six sawtoothed projections on each side of the thorax. The larvae develop in flour, cereal products, and many other dried foods. Consequently, it is a common pest in grain bins, elevators, mills, processing plants, warehouses, and kitchens. In grain bins, it feeds on broken kernels and grain residues. Adults live as long as 3 years. During this period the female deposits up to 300 eggs around and within the infested product. The slender, white larvae hatch within 5 days and crawl to other kernels to feed. About 4 weeks is required for the development from egg to adult.
10. **The sawtoothed grain beetle (*O. surinamensis*) and the merchant grain beetle (*O. mercator*)** are similar in appearance. The merchant grain beetle has an eye diameter larger than the temple region immediately behind the eye and the head is more rectangular than the sawtoothed grain beetle. Generally the merchant grain beetle is larger and darker brown than the sawtoothed. The merchant grain beetle can fly and is more often a pest of oilseeds and their products while the sawtoothed grain beetle prefers grains and cereal products. The life histories of these two species are similar. There are typically 3 larval instars.

Stored Grain and Cereal Product Insect Pests

University of Minnesota



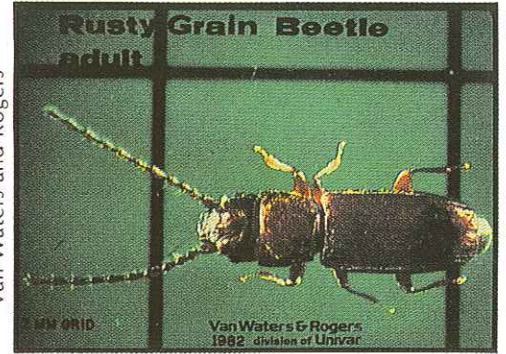
11. Foreign grain beetle adults (*Ahasverus advena*)

University of Minnesota



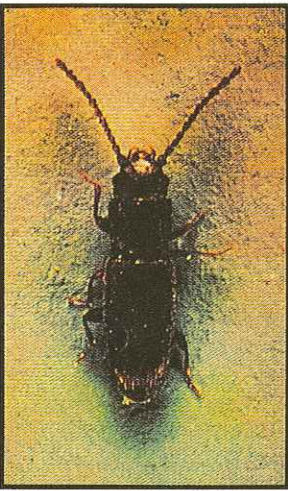
12. Larger black flour beetle larvae (*Cynaesus angustus*)

Van Waters and Rogers



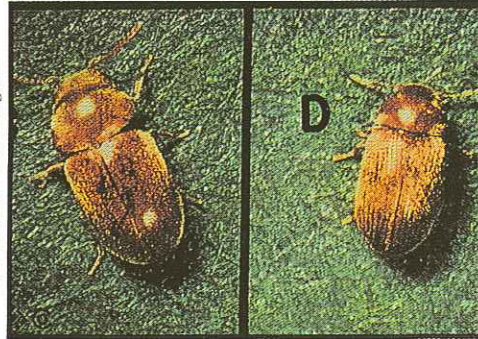
13. Rusty grain beetle adult (*Cryptolestes ferrugineus*)

U.S. Dept. of Agriculture



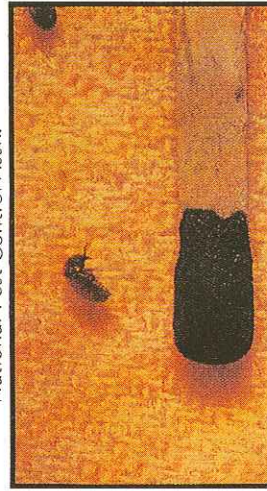
14. Flat grain beetle adult (*Cryptolestes pusillus*)

Van Waters and Rogers



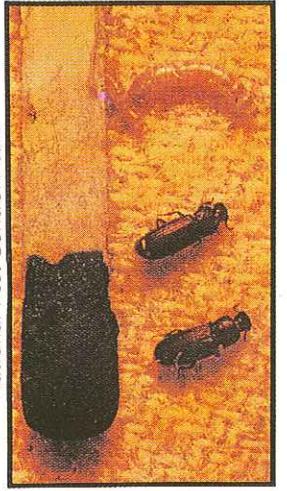
15. Cigarette beetle and drugstore beetle adult (*Lasioderma serricorne* and *Stegobium paniceum*)

National Pest Control Assn.



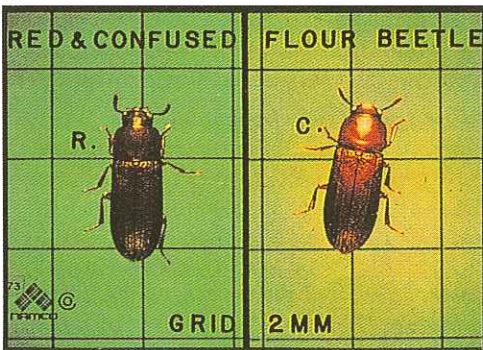
16. Cigarette beetle adult (*Lasioderma serricorne*)

National Pest Control Assn.



17. Confused flour beetle adults and larvae (*Tribolium confusum*)

Van Waters and Rogers

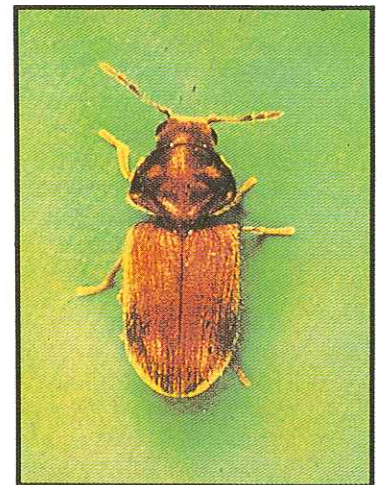


18. Red flour beetle and confused flour beetle adults (*Tribolium castaneum* and *Tribolium confusum*)

U.S. Dept. of Agriculture



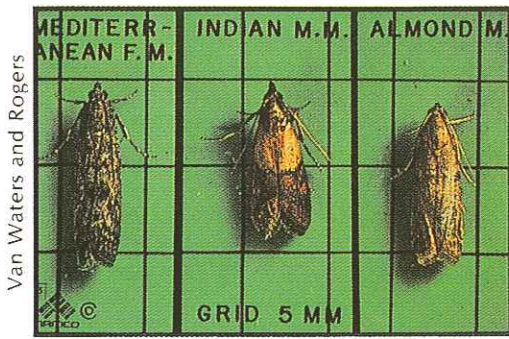
19. Hairy fungus beetle adult (*Typhaea stercorea*)



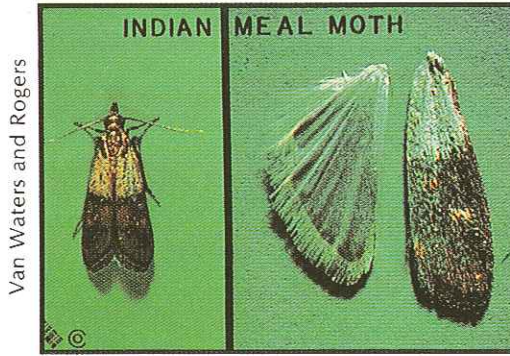
20. Drugstore beetle adult (*Stegobium paniceum*)

11. **The foreign grain beetle, *Ahasverus advena***, is distributed worldwide and is known to infest grain and cereal products, copra, cocoa, peanuts, other oil seeds and their products, dried fruit, herbs, spices and roots. The adult is a small reddish-brown beetle with characteristic projections at the anterior corners of the prothorax. It is a strong flyer and is attracted to high moisture, moldy food products. The female lays eggs singly or in small clusters. The larvae emerge in 4 to 5 days and complete their development through 4-5 larval instars in about 15 days. Adults have an average lifespan of 215 to 250 days.
12. **The larger black flour beetle, *Cynaesus angustus***, has become common in farm stored corn, oats and barley in the North Central States. Corn with a high moisture content is generally preferred. The larvae (as shown) attack the germ by feeding through the pericarp. It is a stout, reddish-brown or black beetle about 1/4" long. This insect has been known to live for at least 1 year under favorable conditions. Each female has the potential to lay 360 to 450 eggs. The life cycle usually required 6 to 10 weeks.
13. Six species of the genus *Cryptolestes* are known to infest stored products. Of these the rusty grain beetle, *C. ferrugineus* is one of two species that is cosmopolitan. The adult is minute (1/16" long) flattened, oblong, and reddish-brown. The antennae of the males are not more than 1/2 the length of the body. Eggs are usually deposited singly in crevices or furrows in kernels of grain. The eggs hatch within 5 days and the adults emerge in 70 to 100 days after hatching. The larvae feed on the germ and endosperm while the adults feed on damaged grain and wheat dust.
14. **The flat grain beetle, *Cryptolestes pusillus*** is one of the smallest beetles in stored grain. It is similar in size, color and form to the rusty grain beetle with antennae about two-thirds as long as the body. It is the second species of *Cryptolestes* that is cosmopolitan and is one of the most common insect pests of stored grain, especially grain that is wet and moldy. The female beetle deposits small, white eggs in crevices in the kernels or drops them loosely upon starchy material. The larvae prefer to eat wheat germ and many kernels are uninjured except for the removal of the germ. When fully grown, the larvae form cocoons of a gelatinous substance to which food particles adhere. They transform into the pupal stage in these cocoons and later emerge as adults. The average development period is about 9 weeks. Flat grain beetle adults can live for a year and fly readily to infest new food sources.
15. **The drugstore beetle, *Stegobium paniceum* and the cigarette beetle, *Lasioderma serricorne*** are similar in appearance. The adults are about 1/10" long, 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 3-segmented saw-like antennae that is pressed to the body when at rest. The antennae of the cigarette beetle are sawlike and the head is somewhat retracted.
16. Physical characteristics of the **cigarette beetle *L. serricorne*** are identified under the description for picture 15. It occurs throughout the tropical and subtropical regions of the world and is a common pest in heated buildings throughout the temperate regions where it breeds in a wide variety of food products. About 100 eggs are deposited by each female singly in crevices, folds or depressions in food and the young active larvae emerge in 5 to 20 days depending on the temperature. The developmental period from egg to adult is also quite variable but under favorable conditions is 6 to 8 weeks.
17. **The adult confused flour beetle, *Tribolium confusum***, is reddish brown, shiny and somewhat flattened. The adults of *T. confusum* and the red flour beetle, *T. castaneum* are so similar in life history, habits and appearance (1/7" long) that the name *T. confusum* was selected because of our difficulty in identifying it properly. The confused flour beetle is one of the most abundant and injurious pests of flour mills in the U.S. Its average life span is 1 year during which time the female lays about 450 sticky white eggs scattered loosely in the food material it infests. In 5 to 12 days the small, cylindrical, larvae emerge to feed on cereal products. When full grown (3/16" long), the larvae pupate with the life cycle complete in about 6 weeks at 90°F.
18. Although the **confused flour beetle, *T. confusum*** and the **red flour beetle, *T. castaneum***, are similar there are important differences in appearance between the two. The antennae of the red flour beetle has a 3-segmented, club-like terminal section whereas the antennae of the confused flour beetle gradually enlarges and is composed of 4 segments. In addition, the thorax of the red flour beetle is curved compared to the somewhat straighter sides of the confused flour beetle. Also the head margins of the confused flour beetle are expanded and notched at the eyes while the head margins of the red flour beetle are nearly continuous at the eyes. The immature stages of the two insects are so similar it is nearly impossible to distinguish between them.
19. **The hairy fungus beetle, *Typhaea stercorea*** is a small (1/10" long) hairy-brown beetle. It resembles the drugstore beetle but differs in having a club-like antennae instead of a saw-like antennae. This beetle is cosmopolitan, prefers stored shelled corn especially if it is moldy and is often found in dwellings, warehouses, stores and flour mills.
20. **The drugstore beetle, *S. paniceum*** infests many products including drugs, spices, stored grain, black and red pepper, tobacco, books, wood and various textiles. Although cosmopolitan, it prefers more temperate than tropical areas. Adult drugstore beetles are 1/10" long with a cylindrical, light-brown body covered with fine, silky hairs. Eggs are deposited in almost any dry organic matter with the small white larvae tunnelling into these substances as they develop through 4 to 6 instars. The last instar constructs a pupal chamber. The insect remains within this chamber for variable periods with the entire life cycle passed within 60 days.

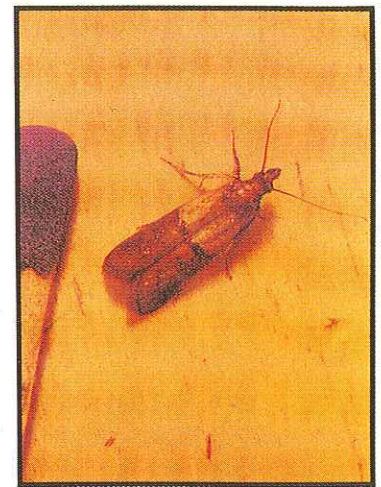
Stored Grain and Cereal Product Insect Pests



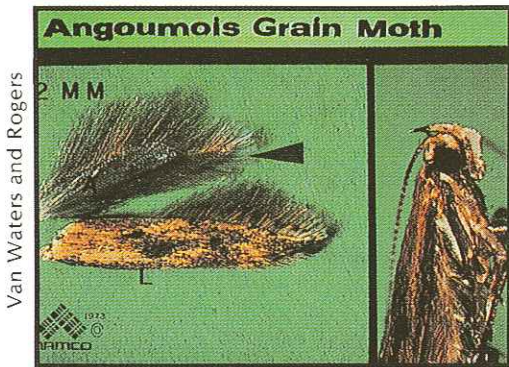
21. Mediterranean flour moth, Indianmeal moth, Almond moth (*Anagasta kuehniella*, *Plodia interpunctella*, *Cadra cautella*)



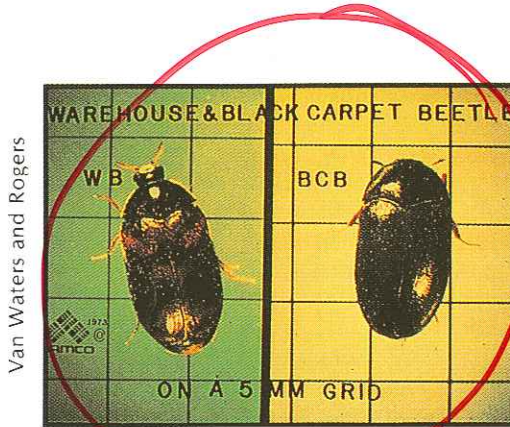
22. Indianmeal moth wing characteristics (*Plodia interpunctella*)



23. Indianmeal moth (*Plodia interpunctella*)



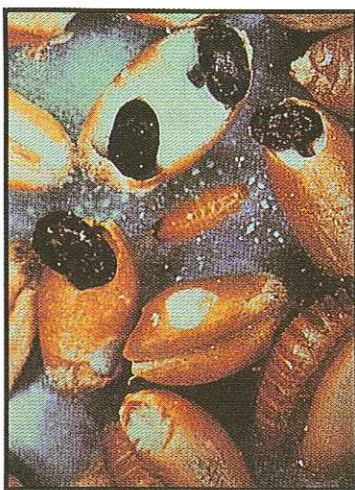
24. Angoumois grain moth (*Sitotroga cerealella*)



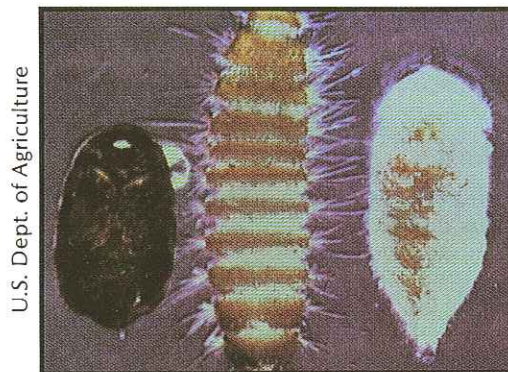
25. Warehouse beetle and black carpet beetle adults (*Trogoderma variabile*, *Attagenus megatoma*)



26. Black carpet beetle larvae (*Attagenus megatoma*)



27. Kharpra beetle adults and larvae on infested wheat kernels (*Trogoderma granarium*)



28. Kharpra beetle adult, larva and pupa (*Trogoderma granarium*)



29. Slender horned flour beetle adult (*Gnathocerus maxillosus*)



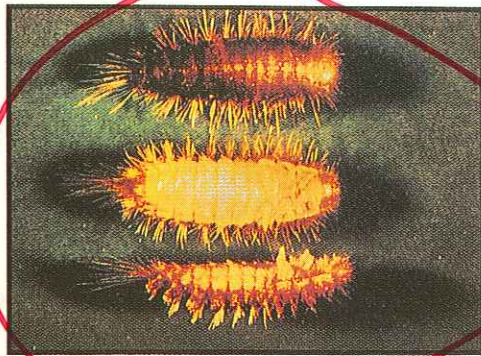
30. Square necked grain beetle (*Cathartus quadricollis*)

21. **The Mediterranean flour moth, *Anagasta kuehniella*, the Indianmeal moth, *Plodia interpunctella* and the Almond moth, *Cadra cautella*** have been established as insect pests on grain and cereal products throughout various areas of the U.S. for many years. However, they differ in identification characteristics and their preferred sites of infestation. The adult Mediterranean flour moth has pale gray forewings (about 1" wingspan) with wavy black transverse lines. The Almond moth is slender compared to the Mediterranean flour moth and is less conspicuously marked. Wings of the Indianmeal moth have 3/4" span with the outer two-thirds of the forewings, reddish-brown with a copper-like luster.
22. The basal half of the front wings of the **Indianmeal moth, *P. interpunctella*** are light colored with the distal portion reddish-brown to copper. The hind wings lack distinctive markings and are more or less uniformly gray. The wing span ranges from 1/2" to 3/4".
23. A third view of the **Indianmeal moth, *P. interpunctella*** may be helpful in understanding their size and wing pattern. The coppery-colored scales may be lost resulting in misidentification.
24. **The Angoumois grain moth, *Sitotroga cerealella*** is a comparatively small (wing span 1/2") buff-colored stored-grain moth. It attacks all cereal grains throughout the world and, as other species of stored-product insect pests, is particularly injurious in the South where it attacks grain in the field as well as in storage. Each female lays 40 to 400 eggs. Emerging larvae usually migrate to single kernels upon which they spin a small cocoon to assist in penetrating the kernel. When the larvae are fully grown within the kernel, they prepare an exit flap through which they escape as adult moths. The time for a complete life cycle is about 5 weeks.
25. **The warehouse beetle, *Trogoderma variabile***, infest a wide range of food materials. The female deposits eggs singly and loosely in broken grain kernels or in crevices of whole kernels. Within 7 days the larvae emerge and develop through 6 instar stages. Development from egg to adult varies from 30 to 40 days. Adult beetle identification is difficult because of the variable color patterns. **The black carpet beetle, *Attagenus megatoma*** adult is a small (3/16" long) oval beetle. Its head and thorax are black, the wing covers are black or dark-reddish brown and are covered with short hairs. Its legs and antennae are dark yellow. Under favorable environmental conditions, the life cycle is completed in 1 year. Adults live 2-4 weeks with each female depositing about 100 eggs.
26. The larval stage of the **black carpet beetle, *A. megatoma***, is quite easy to identify. When reaching maturity, the larva is 1/2" to 3/4" long, excluding the tuft of hairs from its tail. Short, stiff, golden to dark brown hairs cover the entire larval body. The larvae curl up when disturbed and are repelled by light.
27. **The Khapra beetle, *Trogoderma granarium***, is one of the world's most serious insect pests of stored grain. The larvae feed on a wide variety of stored products and, unlike most other Dermestids, it prefers whole grain and cereal products instead of products of animal matter. Adults, with ideal conditions, are usually short lived (4-16 days). However, they are able to survive several months under adverse conditions without food or water and still complete their life cycle. The white eggs (125 per female) are 1/64" long, laid singly and are usually deposited loosely in the infested product or tucked in the grooves or cracks on the kernel. The number of larval instars varies widely (4-8) depending on the environmental conditions. The larva is yellowish brown and about 1/4" long. A typical infestation usually has a large number of larvae plus their cast skins. The development from egg to adult requires 26 days at 94°F to 220 days at 73°F. It has constantly increased its area of infestation during the present century and, with the possible exception of South America, has been confirmed as an infestor on every continent.
28. **The Khapra beetle, *T. granarium***, is similar in appearance to many of the other species of *Trogoderma*. It usually requires a highly trained specialist to confirm identification. Adult males are small (1/8" long) brownish-black beetles. Generally females are slightly larger and lighter in color than males. Both have yellowish brown and reddish brown markings on the wing covers which also are covered with fine hairs. The larvae are covered with thick, reddish brown hairs with two tufts at the end of the abdomen. Pupae are about 1/4" long and are enclosed inside the last larval skin. Pupal development requires 3 to 6 days and usually occurs in the top layer of food material. The adults do not fly.
29. **Slenderhorned flour beetles, *Gnatocerus maxillosus***, infests a wide variety of commodities including most cereal grains, pulses and peanuts. The adult beetle is about 1/8" long. The males have slender, incurved horn-like mandibles or jaws. Its habits are similar to those of the broadhorned flour beetle *G. cornutus* but it is less common in the United States and is more or less confined to the southern states. The average development period from egg to adult is 35 to 40 days at 86°F but exceeds 100 days at 68°F.
30. **The squarenecked grain beetle, *Cathartus quadricollis***, is cosmopolitan and infests wheat, rolled barley, rice, ripe fruits, cocoa, tobacco, and oil palms. It is also known to attack corn in the field, especially in the southern U.S. It is a flattened, oblong, polished, reddish-brown beetle about 1/10" long. It differs from the sawtoothed grain beetle, *O. surinamensis*, to which it is closely related, by its almost square thorax but lacks the sawtooth-like projections. The immature resemble those of the sawtoothed grain beetle in both form and habit. The larvae usually devour the germ of seeds in which they feed. These insects develop from egg to adult in 3 to 6 weeks.

Stored Grain and Cereal Product Insect Pests



31. Trogoderma glabrum adult



32. Trogoderma inclusum larvae



33. Trogoderma simplex adult



34. Trogoderma simplex larva



35. Trogoderma variabile larvae



36. Trogoderma variabile adult



37. Spider beetle adult (Gibbium psylloides)



38. Psocid adults (Liposcelis spp.)



39. Yellow mealworm adult (Tenebrio molitor)



40. Black flour beetle adult (Tribolium audax)

31. *Trogoderma glabrum* larvae infest a wide variety of plant and animal substances, including stored wheat and shelled corn. They restrict their feeding to the upper 2-3' of binned grain where they consume the germ initially before going into the endosperm and bran. Adult *T. glabrum* do not feed. The total developmental period from egg to adult averages 140 days at 70°F to 45 days at 100°F. Longevity of adults varies from 7 to 42 days.
32. *Trogoderma inclusum* also has diverse feeding habits as it infests processed foods, mixed animal feeds and raw agricultural products. The adults of this small cosmopolitan beetle mate soon after emerging from the pupae. Each of the 10 to 45 whitish eggs have threadlike projections on one end which adhere to anything they contact. The eggs hatch in 8 to 12 days and the larvae live 5 months. They pupate for 10-14 days. Adult *T. inclusum* do not eat and live 8 to 25 days.
33. *Trogoderma simplex* adult males have a black head and pronotum. The wings are black or black with a variable reddish pattern. Their antennae are light brown and 11 segmented. Dorsal body surfaces have coarse, erect hairs that may be gold, brown or white. This species is indigenous to North America from the Rocky Mountains west to the Pacific coast.
34. *T. simplex* larvae are most readily identified from other *Trogoderma* species by dense clusters of short hairs along the center of the thorax and the first 4-5 abdominal segments. In general, their life history is similar to the Khapra beetle (*T. granarium*), but it may be remarkably altered in its duration by variations in temperature, food and humidity.
35. The warehouse beetle, *Trogoderma variabile*, normally has six larval instars but many fully developed larvae enter diapause and remain so for 2 years. Non-diapausing larvae require about 34 days to develop. The larvae feed on seeds of all kinds and many plant and animal products. The larva is about 1/4" long and varies from yellow white to dark brown depending on its age. They have two major types of hairs; the spear-headed hairs with numerous barbs and the slender elongate hairs resembling a rat tail with many smaller, sharp pointed hairs attached. The structure of these hairs and their abundance (about 4000/larva) may be a source of irritation to people eating products infested with these larvae.
36. Adult warehouse beetles, *T. variabile* are brownish black, about 1/8" long and can fly. The eggs (laid loosely and singly) hatch in about 7 days with the total life developmental period ranging from 32 to 37 days. The warehouse beetle occurs throughout most of the U.S. and is one of the most common stored-product pests in sea-ports throughout the world.
37. There are several species of spider-like beetles infesting grain and cereal products. **Spider beetles** are widespread in distribution, but rarely show up in economic numbers in the U.S. As adults they are about 1/7" long, lay eggs in the products they infest and require about 3 months to develop from egg to adult.
38. **Psocids (or booklice)** are small (1/25" long), pale colored, wingless, softbodied insects with large heads, long slender antennae and poorly developed eyes. Each female lays about 100 eggs with a development period to adult in about 3 weeks. Newly hatched young resemble adults but are smaller and lighter colored. They are widely distributed in North America and Europe and are usually concentrated in moist products.
39. **The yellow mealworm, *Tenebrio molitor***, is one of the largest insects that infest cereal products. The adult (1/2" long) is a shiny, black or reddish-brown beetle with a finely punctured thorax and longitudinally grooved wing covers. Female adult mealworms lay about 300 white, bean-shaped eggs coated with a sticky substance that causes flour and other particles to adhere to them. Larvae are 1 1/4" long when fully grown and may require more than 600 days to develop. Usually the complete life cycle takes 10 months to two years.
40. **The black flour beetle, *Tribolium audax***, is occasionally noted in flour, meal, seeds and grain. It occurs throughout the northern and western U.S., southern Canada, central and northern Europe, and Egypt.

Distributed by the Department of Entomology, University of Minnesota

Developed by Phil Harein, Entomology Department
 University of Minnesota
 St. Paul, MN 55108
 and
 Distributed by the Office of Special Programs
 University of Minnesota
 St. Paul, MN 55108