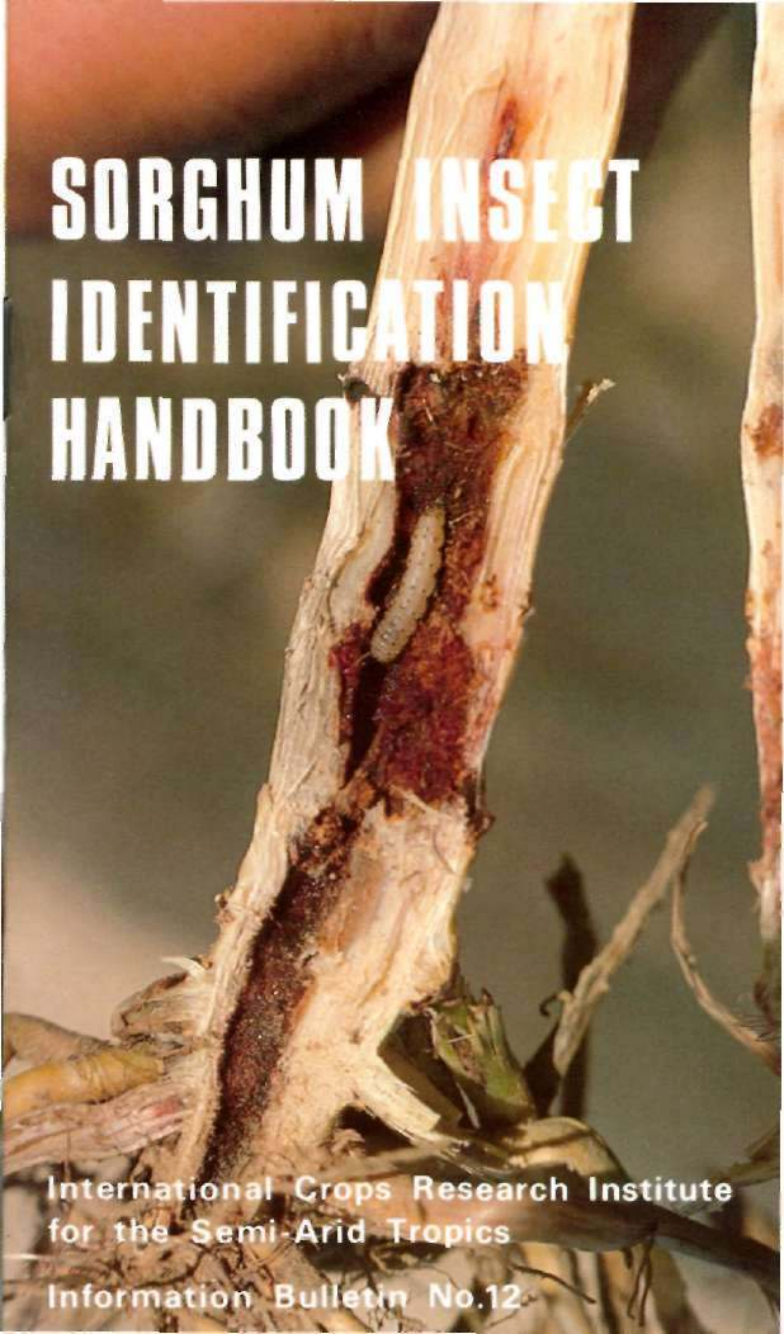

SORGHUM INSECT IDENTIFICATION HANDBOOK

International Crops Research Institute for the Semi-Arid Tropics

Information Bulletin No.12

Author's Note

This handbook has been published to help agricultural scientists and students to identify the common insect and mite pests of the sorghum crop at all stages of growth, and in storage.

To create awareness about the benefit of natural enemies there is a section on the more well known predators and parasites of sorghum pests. General descriptions of the pests and color illustrations are provided to facilitate identification. There are brief descriptions of the biology, nature, and symptoms of damage together with suggested control measures. Chemical control should be applied only if really necessary, and a plant protection specialist should be consulted beforehand, if possible. It is always preferable to confirm the identity of pests with the help of professional entomologists and to collect specimens for future identification when the opportunity arises.

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Cover: Stem Borer larvae (*Chilo partellus*) damaging sorghum stem.

SORGHUM INSECT IDENTIFICATION HANDBOOK

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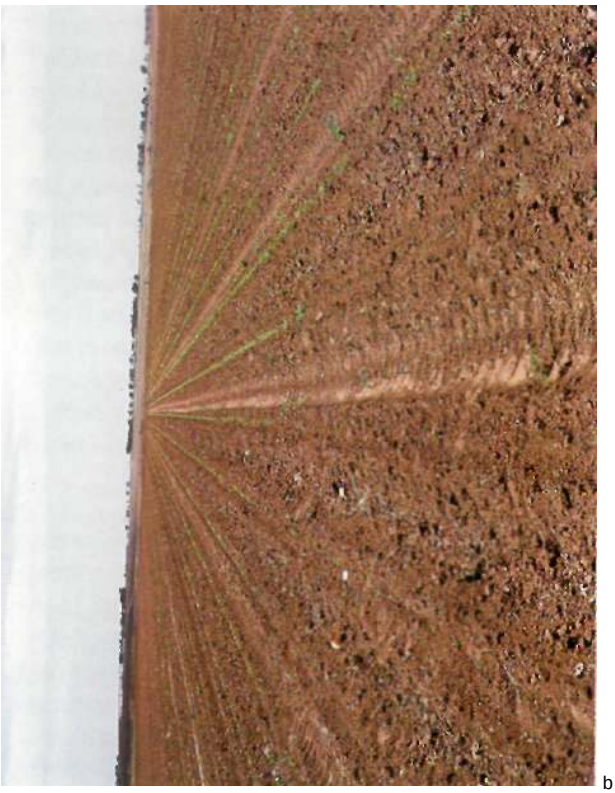


b

Wireworms: Several species (Elateridae: Coleoptera) (Click beetles) (Tenebrionidae: Coleoptera) (False Wireworm. darkling beetles)

Distribution. Pest species of both genera are present worldwide.

Symptoms. Several species of Elateridae and Tenebrionidae attack the planted seed and, to a lesser extent, the roots of sorghum. Larvae feed on sorghum soon after the seeds are planted. They hollow out the grain kernels (Fig. 1 a). This feeding prevents germination. The symptoms of wireworm damage in fields are bare areas of various sizes and a general thinning of the crop stand (Fig. 1b).

Description and Biology. The biology and appearance of wireworms depend on the species involved, and our descriptions here are general and apply to the entire group. Wireworms attacking sorghum deposit eggs in clusters in the soil. They are minute, oval, and pearly white. Young larvae are creamy white but change to a shiny yellow as they grow older. Fully grown larvae reach a length of about 25 mm. They transform to fragile white pupae. The adults are brown to nearly black beetles. 7-13 mm long. Depending on species, a generation requires 1, 2, or many years.

Control. Seed treatment with insecticides (heptachlor, lindane, diazinon) reduces damage by approximately 90%.

SOIL INSECT

a

b

c

White Grubs: *Phyllophaga crinita* (Burmeister) (Scarabaeidae: Coleoptera)

Distribution. Several species of white grubs belonging to several genera are worldwide pests of a wide range of crops, including sorghum. *P. crinita* is restricted to America (mainly in temperate regions).

Symptoms. The most obvious and significant damage to sorghum by *P. crinita* often occurs during the spring soon after the plants have emerged from the soil. Seed germination occurs and a satisfactory stand is established but, within a short period, when the plants are 100-150 mm tall, seedlings begin to die (Fig. 2c). Stand loss can occur within 7-10 days in severely infested fields. One grub can destroy all plants along 5 m of a row (Fig. 2b). Uninfested plants produce normal roots; however, infested plants that are not killed as seedlings are severely stunted and may never produce grain. A third type of damage results from root pruning by overwintered as well as current-season larvae. Injured plants, although able to produce seed heads after such damage, frequently do not have sufficient roots to prevent lodging. Occasionally, lodging is increased by secondary stalk rot organisms.

Description and Biology. Adults, commonly referred to as May or June beetles, are brownish-black and 13-19 mm long (Fig. 2a). Only larvae are injurious to sorghum, feeding on plant roots. They are C-shaped with brown heads and white bodies (Fig. 2a). Fully grown larvae reach a length of 20mm. Undigested food can be seen through the shiny, transparent tip of the abdomen. Depending on species, the life cycle may require 1, 2, or more years. In temperate areas, the pests survive the winter as larvae.

Control. Depending on the species, early or delayed planting or rotation with a non-grass crop, and a preplant application of insecticide (i.e., diazinon) are recommended control measures. The economic threshold level in the USA was found to be one grub per 3 m^3 of soil.

Fig. 3

SOIL INSECT

a

b

Cutworms: Many species
(Noctuidae: Lepidoptera)

Distribution. Cutworm species are distributed worldwide.

Symptoms. Larvae cut off sorghum plants at or slightly below the soil surface (surface feeders) (Fig. 3b). Some feed on above-ground plant parts (climbing or army cutworms), while others feed on underground plant parts.

Description and Biology. The typical cutworm larva found attacking sorghum has a plump, curled-up appearance (Fig. 3a). Larvae vary with species from grayish-white to grayish-black or brown. Fully-grown, they are 30-50 mm long. The pupa is naked, brown, and 20 mm long. The moths are usually gray to brown with a wing expanse of 40-50 mm. Eggs are usually ribbed and subconical, 0.65 mm in diameter. They are laid on stems or leaves of sorghum or in the soil and hatch in 2 days to 2 weeks. The majority of cutworms pass the winter or dry season in the partly-grown to fully-grown larval stage. Some, however, hibernate in the soil as adults and others as pupae. In typical cases in temperate areas, the worms remain during the winter as small larvae in cells in the soil, under trash or in clumps of grasses. They start feeding in the spring and continue growth until early summer, when they pupate in the soil. The larvae in most cases remain underground during the day and feed at night.

Control. Cultural controls include plowing under of vegetation in late summer or early fall, or 3-6 weeks prior to planting, destruction of weed host plants, and thorough seedbed preparation. Piosoned baits are highly effective against a few species, but insecticide sprays and dusts are most commonly used as a broadcast treatment of the ground and plants. For bait preparation dipterex, thiodan, or aldrin are recommended, while for spray treatment of seedlings carbaryl, thiodan, and trichlorphon give sufficient control.

SOIL INSECT

a

b

Southern Corn Rootworm:

Diabrotica undecimpuncta howardi (Barber) (Chrysomelidae: Coleoptera)

Distribution. The larva of this New World pest is known as the southern corn rootworm, while the adult is the spotted cucumber beetle.

Symptoms. The rootworm bores into the roots of sorghum or commonly enters the stalk just above the roots (Fig. 4b). Here it eats out the crown of young plants and kills the growing point. The symptoms of damage are stunting and deadhearts. Young plants are most commonly affected.

Description and Biology. The egg is oval, 0.5 mm long, pale yellow, and sculptured with hexagonal pits. The larvae are slender, white or pale yellow, and grow to a length of 12 mm (Fig. 4a). The last segment of the abdomen has a nearly circular margin and is brown. The pupa is white and fragile. The adult is 6 mm long and yellowish-green with 11 black spots on the fore wings. It has a black head and antennae that are one-half to two-thirds of the length of the body. In temperate regions the adult overwinters in shelters of trash, or it may be active during mild winters. In the spring females deposit eggs in the soil around the base of plants. There are 2 generations per year.

Control. Cultural control practices include keeping fields free of grassy weeds, plowing and discing 30 days before planting, rotation (for at least 2 years) with a non-grass crop, early planting, and planting at a higher-than-normal seed rate. An in-furrow insecticide application at planting with diazinon is also effective.

Fig. 5

FOLIAGE FEEDER

a

b

c

Greenbug: *Schizaphis graminum* (Rondani) (Aphididae: Homoptera)

Distribution. The species is widely distributed in Asia, Africa, Australia, and America.

Symptoms. Infestations are detectable by the apearance of reddish spots on the leaves caused by toxins injected into the plant. The reddened areas enlarge as greenbug numbers increase. The leaves then begin to die, turning brown from the outer edges. The aphids feed in colonies on the underside of the foliage, and produce an abundance of honeydew. Greenbugs also transmit maize dwarf mosaic virus and may predispose sorghum to charcoal rot. The greenbug may be a pest during the seedling stage (Fig. 5b) although often it does not reach damaging proportions until heading (Fig. 5c).

Description and Biology. The adult aphid is 1.6 mm long. It is light green with a darker green dorsal abdominal stripe (Fig. 5a). The distal leg segments and comical tips are black. Winged and wingless forms may be present in the same colony. Females produce living young (nymphs) without mating. Under optimum conditions the life cycle is completed in about 7 days, and each female produces about 80 offspring over a 25-day period.

Control. Rain and predators suppress the aphid population. The rate of increase has been recorded in the field as high as 20-fold per week. In the USA the parasite *Lysiphebus testaceipes* is usually responsible for the eventual decline of aphid numbers. The aphid is normally highly susceptible to most organophosphate insecticides (metasystox, diazinon, malathion, etc.), but resistance to several of them has been recorded. Greenbug-resistant sorghums are commercially available in the USA, and are recommended.

Fig. 6

FOLIAGE FEEDER

a

b

c

Corn Leaf Aphid: *Rhopalsiphum maidis* (Fitch) (Aphididae: Homoptera)

Distribution. The corn leaf aphid often becomes extremely abundant and is found in all sorghum-growing areas of the world.

Symptoms. The aphid is most commonly found deep in the whorl of the middle leaf, but also on the underside of leaves, on stems, or in panicles (Fig. 6a). The young and adults suck the plant juice. This frequently causes yellowish mottling of the leaves (Fig. 6 b). They may cause some marginal leaf necrosis (Fig. 6 c). The aphid produces an abundance of honeydew on which molds grow. In panicles, honeydew may hinder harvesting. The aphid also transmits maize dwarf mosaic virus.

Description and Biology. The aphid is dark bluish-green and somewhat ovate. It is 2 mm long, with black legs, cornicles, and antennae. Winged and wingless forms occur. Females give birth to living young without mating and a generation requires only a week or so. In mild temperate climates the insect is active throughout the winter.

Control. Control of corn leaf aphids is seldom justified. Although present in relatively large numbers, yield losses rarely occur. The aphid is readily controlled with organophosphates, especially systemic insecticides. In some cases the presence of corn leaf aphids is beneficial in that natural enemies often become abundant and serve to suppress other insect pests. Since the aphid prefers the whorl of sorghum, emergence of the panicle results in a significant decline in crop density.

Fig. 7

FOLIAGE FEEDER

a

b

Sugarcane Aphid: *Melanaphis sacchari* (Zehntner) (Aphididae: Homoptera)

Distribution. Present in many parts of Asia and Africa and tropical America.

Symptoms. In contrast to many other aphid species *M. sacchari* prefers to eat older leaves (Fig. 7b). But it also infests younger leaves and panicles at the flowering stage (Fig. 7a). Both adults and nymphs suck sap and can cause stunted plant growth. The damage is more severe when the crop is under moisture stress, resulting in the drying of leaves and plant death. The aphids excrete honeydew on which sooty mold grows.

Description and Biology. The sugarcane aphid is yellow to buff. Numbers increase rapidly during dry spells or at the end of the rainy season. The female of the wingless form deposits 60-100 nymphs within its reproductive period of 13-20 days. The winged form produces slightly fewer nymphs. The life cycle is completed in 5.5-7.0 days during the dry season.

Control. A large number of predators feed on this insect and chemical controls are usually not required. But metasystox or malathion is recommended if infestation is severe.

Fig. 8

FOLIAGE FEEDER

a

b

c

Yellow Sugarcane Aphid: *Sipha flava* (Forbes) (Aphididae: Homoptera)

Distribution. This aphid is an occasional pest of sorghum in the New World.

Symptoms. The aphid attacks sorghum at the seedling stage, and also older plants. In both cases it prefers the older lower leaves. Feeding aphids secrete a potent toxin which causes the death of the seedling. As few as 5-10 aphids per leaf can kill sorghum plants up to 450 mm in height. The initial symptom of aphid damage on seedlings is a purpling of the leaves (Fig. 8b). On older plants a severe yellowing of leaves results from feeding (Fig. 8c). Plant stunting also occurs and damage often leads to plant lodging that may be enhanced by associated stalk rots.

Description and Biology. The yellow sugarcane aphid is lemon yellow, 2 mm long, and covered with setae (hairs). It has two rows of dark tubercles down the dorsum (back) (Fig. 8a). Without mating, females give birth to living young for a period of 28 days, and nymps mature in 13-19 days and live for 25-50 days. Females produce about 18 nymphs, at an average daily production of two. Both winged and wingless forms exist in the same colony.

Control. Currently, insecticide application is the only measure used for the control of the yellow sugarcane aphid in sorghum. Recommended insecticides are: dimethoate, metasystox, and fenitrothion. Many common predators in the field feed on the aphid, but it is rarely parasitized.

Fig. 9

FOLIAGE FEEDER

a

b, c

d

Shoot Bug: *Peregrinus maidis* (Ashmead) (Delphacidae: Homoptera)

Distribution. The shoot bug as a plant pest is common in India, and in certain parts of Africa, the West Indies, Bermuda, and the Philippines.

Symptoms. On sorghum, nymphs and adults suck sap causing the plants to appear unhealthily yellow. Plant growth becomes stunted. In severe cases of infestation the top leaves start dying first (Fig 9d), but leaf death gradually extends to older leaves and, sometimes, death of the whole plant occurs. High infestation at the boot stage may twist the top leaves and prevent the emergence of panicles (Fig. 9d). Honeydew excretion favors the growth of sooty mold.

Description and Biology. The female is yellowish-brown and the male dark brown (Fig. 9c). Wings of adults of both sexes may be longer or shorter than the abdomen. Long-winged forms have transparent wings. Wings of the short-winged forms extend only to the sixth abdominal segment. Females are nearly one-and-a-half times larger than the males. The nymphs (Fig. 9a) and adults live in groups on the leaves, within leaf whorls, and on the inner side of leaf sheaths. The female makes a slit on the upper surface of the leaf midrib and inserts the eggs in groups of one to four and covers them with a white waxy substance (Fig. 9b). A female lays a maximum of 100 eggs in 7 days. They are white, elongate and cylindrical and they taper slightly at the ends. The incubation period is 7-10 days. There are 5 nymphal instars that are completed in about 16 days.

Control. Several predators and parasites attack this pest. Endosulfan or carbaryl are effective insecticides.

Fig. 10

FOLIAGE FEEDER

a

b

Spittle Bug: *Poophilus costalis* Walker (Aprophoidae: Hemiptera)

Distribution. This pest is found in Africa and certain parts of Asia.

Symptoms. The bug sometimes causes considerable damage by feeding on sorghum leaves and within leaf whorls, resulting in chlorotic spots and blotches on the leaves. In severe cases of infestation the plants become stunted in growth, producing smaller panicles. The pest can attain high densities in late or phased plantings.

Description and Biology. The adult bugs are small jumping insects 9-11 mm long. They are usually brown or gray (Fig. 10a). The nymphs always remain inside a foamy spittle mass resting head downward on the plant (Fig, 10b). In each mass there is one or more—even up to 25—brownish or grayish nymphs. The nymphs leave the spittle after the last molt and become active.

Control. Chemical control is not required because most infested plants do not suffer much damage, and recover soon after the insects have become adults and have departed.

Fig. 11

FOLIAGE FEEDER

a

b

Chinch Bug: *Blissus leucopterus* (Say) (Lygaeidae: Heteroptera)

Distribution. It is widely distributed in North America.

Symptoms. Chinch bugs destroy plants principally by withdrawing enormous quantities of sap from their stems (Fig. 11b) or underground plant parts. Young plants are highly susceptible. Older and tougher plants are better able to withstand attack but they, too, become reddened, weak, and stunted, and then frequently lodge.

Description and Biology. Eggs are laid on host plants behind the lower leaf sheaths, on roots, or in the ground nearby. Eggs are 0.8 mm long. Newly hatched nymphs are pale yellow (Fig. 11b), but soon become red except for the first two abdominal segments. Subsequent instars become darker red but retain a pale yellow band across the forward part of the abdomen (Fig. 11a). The last instar is black and gray with a conspicuous white spot on the back between the wing pads. The 4.2-mm long adult chinch bug is black, with conspicuous white fore wings, each of which has a black triangular spot at the middle of the outer margin (Fig. 11a). The life cycle is completed in 30-40 days and there are normally two generations a year. Chinch bugs overwinter as adults in bunch grass. Migration begins when temperatures reach 21℃ or higher.

Control. Cultural practices, barriers against migrating nymphs, and application of insecticides are the usual control measures taken against chinch bugs. Sorghum should be planted as early as possible, and cultural practices that stimulate dense, vigorous stands are recommended because they reduce injury. Chinch bugs are sometimes difficult to control with insecticides. Sprays of carbaryl, carbofuran, parathion, or toxaphene, directed at the base of plants, usually suppress bug numbers.

Fig. 12

FOLIAGE FEEDER

a

b

c

Fall Armyworm: *Spodoptera frugiperda* (J.E.Smith) (Noctuidae: Lepidoptera)

Distribution. The fall armyworm is an important pest of sorghum in southeastern USA, and is frequently a limiting factor to sorghum production in tropical America.

Symptoms. In the whorl stage of sorghum growth the young larvae feed on the tender parts of the whorl leaves (Fig. 12c). The unfurled leaves show a regular row of holes across the leaves or irregular elongated feeding areas (Fig 12b). Larvae may also rarely feed on the unemerged panicle. After panicle emergence the larvae feed on the developing grain in the panicle.

Description and Biology. Young larvae are slightly greenish and have black heads. Mature larvae vary from greenish to a grayish-brown, have a light-colored inverted Y-shaped suture on the head, and dorsal lines running lengthwise on the body (Fig. 12a). The moth has variegated gray fore wings (Fig. 12a) Eggs are usually deposited on the underside of leaves in large masses covered with scales and hair of the moth. The insect requires about a month to complete a generation. Diapause or aestivation is not known to occur in any of its life stages. From subtropical and tropical America the adults migrate northward each year as the weather warms up.

Control. The fall armyworm has several important hymenopterous and dipterous parasites, and hemipterous and coleopterous predators. Entomogenous fungi also infect the pest. Early planting in temperate zones is important. Insecticidal control of larvae on small plants is feasible, but is difficult when larvae are deep within the whorl. Treatment of panicles is justified when there are two larvae or more per panicle. Carbaryl is effective.

Fig. 13

FOLIAGE FEEDER

a

b

Oriental Armyworm: *Mythimna separata* (Walker) (Noctuidae: Lepidoptera)

Distribution. The insect is distributed throughout Asia, the Pacific Islands, Austrialia, Fiji, and New Zealand.

Symptoms. The larvae feed on the leaves, leaving only the midrib uneaten (Fig. 13b). The immature panicles are also damaged. Armyworm attacks are sporadic but, if heavy, an entire crop may be lost.

Description and Biology. The moth has brownish fore wings with dark specks; hind wings are whitish-brown. Eggs are laid in batches of 20-100 within the leaf sheath, the leaf folds, or on the soil. The eggs are shining white and spherical, and have fine ridges. The incubation period is 4-5 days. The fully grown larva (Fig. 13a) is dirty pale brown to dark brown with three darker brown dorsal lines. There is a lateral yellow stripe on each side. The entire larval stage usually lasts from 29 to 39 days. The larva pupates within the soil in an earthen cell or sometimes inside leaf sheaths on the plant. The pupal period is 7-10 days. Outbreaks of this armyworm occur after heavy rains, floods, and drought following heavy rains or the mulching of fields.

Control. Clean cultivation and lower plant population help in reducing insect damage. A number of insecticides give effective control of this insect. BHC, carbaryl, phosphamidon, and monocrotophos give effective control of the larvae. A number of hymenopterous and dipterous parasites help to check the pest's population growth.

Fig. 14

FOLIAGE FEEDER

a

b

African (Nutgrass) Armyworm: *Spodoptera exempta* (Walker) (Noctuidae: Lepidoptera)

Distribution. This armyworm is an occasional pest of sorghum in East and West Africa.

Symptoms. It occurs periodically in major outbreaks which result in extensive loss of crops (Fig. 14b). It is a general grass feeder, attacking pasture grasses and other cereal crops. The damage is caused by the larvae. They are gregarious and move through the vegetation at very high infestation rates.

Description and Biology. Eggs are laid by adult females on the undersurface of leaves in groups of 20 or more, and hatch in 3-4 days. The larval period lasts for 10-20 days, depending on the temperature. Solitary larvae are green but the damaging gregarious larvae are usually black with green undersides (Fig. 14a). Pupation occurs in the soil and the adult normally emerges in 1 week. Adult moths can migrate at night over considerable distances and mass increases of native moths can give rise to new outbreaks at considerable distances from source-infestations. Outbreaks are associated with the rainy season and, in eastern Africa, there is a general northward progression with infestations occurring earlier in the south (Tanzania) than in the north (Ethiopia).

Control. Control of major outbreaks can be satisfactorily effected only if national or international organizations apply insecticides in outbreak areas. It is important to detect infestations at an early stage. Small infestations can be controlled by using such insecticides as malathion, endosulfan, and trichlorphon.

Fig. 15

FOLIAGE FEEDER

Red-headed Hairy Caterpillar:

Amsacta albistriga (Walker)
(Arctiidae: Lepidoptera)

Distribution. *A. albistriga* is a pest in India. The closely related species *A. moloneyi* (Dro) has been reported from Africa.

Symptoms. The larvae, which often occur in great numbers, are voracious leaf feeders.

Description and Biology. The adult moth has white fore wings bearing brownish markings and streaks, and the white hind wings have black spots. There is a yellow band on the head and a yellow streak along the anterior margin of the fore wings. Moth emergence occurs in waves following rains. Cream or bright yellow eggs are laid in masses on the lower surfaces of leaves. The eggs may also be laid on the soil, stones, bits of wood, and on other vegetation. A moth can lay up to 2300 eggs. Incubation period is 3-4 days. The dark hairy larvae feed gregariously on the lower surface of leaves, scraping them for 4 or 5 days. After about 10 days larvae become ashy brown and move slowly from plant to plant and field to field, feeding voraciously. In about 40-50 days the larvae become fully grown. They are about 5 cm long and have white spots on the body, dense tufts of long hair, and a red head (Fig. 15). They may move to the edge of the field and feed on alternative hosts prior to pupating in loose soil. Pupae remain in the soil during the dry season and hatch at the beginning of the monsoon rains the following year.

Control. Plowing the field during summer, and collection and destruction of egg masses, help in reducing pest populations. Several parasites and predators attack the pest. Parathion and toxaphene are effective.

Fig. 16

FOLIAGE FEEDER

a

b

Flea Beetle: Many species (Chrysomelidae: Coleoptera)

Distribution. Common all over the world.

Symptoms. Adult flea beetles feed on the leaves of sorghum, especially on seedlings. They create tiny holes in the leaves, and heavily infested plants take on a shot-hole appearance (Fig. 16b). The larvae usually feed on plant roots.

Description and Biology. Flea beetles of several species and genera are small jumping leaf beetles 3-4 mm long. The femurs (thighs) of their hind legs are greatly enlarged. Most adults are blue or greenish, but some are black or black with light markings (Fig. 16a). Little is known about the biology of this group, except that the winter or dry season is usually passed in the adult stage.

Control. The most important control measure is to keep fields free from weeds. In infested regions late planting is recommended so that the crop matures quickly. Several insecticides effectively control flea beetles.

Fig. 17

FOLIAGE FEEDER

Leaf Weevil: *Myllocerus subfasciatus* (Guerin-Meneville)
(Curculionidae: Coleoptera)

Distribution. *Myllocerus* spp, including *M. subfasciatus* and *M. undecimpustulatus,* are widely distributed in India.

Symptoms. Adult weevils feed on the leaf edges, cutting U-shaped patterns along the leaf margins (Fig. 17). The grub (larva) feeds on the roots.

Description and Biology. The adult weevil is about 6 mm long, light grayish to white with four black spots on the wing covers (Fig. 17). The eggs are light yellow and laid deep in the soil. The grubs are fleshy, yellow-colored, and 7-9 mm long. Pupation occurs in earthen cells in the soil. Egg, larval, and pupal periods last for 3-11, 3-42, and 5-7 days respectively.

Control. When outbreaks are severe the use of malathion, trichlorphon, carbaryl or monocrotophos is recommended.

Fig. 18

FOLIAGE FEEDER

a

b

c

Grasshoppers: *Oedaleus senegalensis* (Krauss)
Aliopus simulatrix (Walker)
(Acrididae: Orthoptera)

Distribution. These two species may be major pests of sorghum in Africa along the southern borders of the Sahara. Some other grasshopper species are less frequent pests in all arid parts of the world.

Symptoms. All stages of the plant may be attacked, but most crop loss is inflicted when attack occurs at the seedling stage. or on the ripening of panicles. Both nymphs and adults feed on sorghum (Fig. 18c) as well as on other cereals and wild grasses.

Description and Biology. Adult *O. senegalensis* (Fig. 18a) are 30-40 mm long, and green or brown. *A. simulatrix* is about 25 mm long and is commonly pale brown. Both species are fully winged as adults. They are migrant species, flying at night so that large population increases can occur locally overnight. Nymph development (Fig. 18b) can take place in less than 2 months, but both species have the capacity to survive a long dry season. *O. senegalensis* survives in the egg stage in pods in the ground, and in very dry areas eggs may remain alive for over a year. *A. simulatrix* survives the dry season in the adult stage, hiding in cracks in the soil. Egg-laying in this species is delayed until the start of the rainy season. In both species breeding is continuous in the wetter times of year, with a generation time of 40-50 days.

Control. Control can be achieved using insecticides. Malathion and diazinon are particularly effective against these and many other grasshoppers.

Fig. 19

FOLIAGE FEEDER

a

b

c

Migratory Locust: *Locusta migratoria* L. (Acrididae: Orthoptera)

Distribution. Sometimes a major pest of sorghum in Africa and the Indian subcontinent.

Symptoms. Nymphs and adults feed on the leaf margins, flowers, and ripening panicles (Fig.19c). In addition to sorghum it attacks a wide variety of cereals and grasses, and occasionally other types of plants.

Description and Biology. The insects occur in both solitary and swarming phases. Only in the latter are they sufficiently abundant to be damaging. Adults of the swarming phase are brownish and fully winged, with a length of about 50 mm (Fig. 19a). The nymphs pass through 5 instars and are initially all black, becoming black and orange with age. Various shades of brown and gray may also occur in low-density populations, while solitary nymphs are green. The nymphs occur in dense bands (Fig. 19b) that may move up to several hundred meters in 1 day. The adults form swarms and migrate by day, sometimes over very long distances. Each individual is capable of laying three or four egg pods in the soil with approximately 50 eggs per pod. The total development time may be as short as 3 months so that, under suitable environmental conditions, 4 generations may be produced in 1 year. Under less favorable conditions this number may be reduced to 1 or 2.

Control. Major outbreaks usually start in well-defined areas, and national or international control aimed at preventing the development of outbreak populations is preferable to local action. Bands of nymphs are relatively easily destroyed by conventional insecticides, of which BHC and diazinon are particularly effective.

Fig. 20

FOLIAGE FEEDER

a

b

c

Banks' Grass Mite: *Oligonychus pratensis* (Banks) (Tetranychidae: Acarina)

Distribution. Several species of spider mites, *Oligonychus* spp and *Tetranychus* spp, infest sorghum. Banks' grass mite is the most frequently encountered species n the USA, and *O. indicus* in India.

Symptoms. Spider mites suck sap from the underside of leaves, beginning along the midrib of the lower functional leaves. The infested leaf areas are pale yellow initially and later become reddish on the topside of the leaves (Fig. 20c). The entire leaf may turn brown. As mite numbers increase on the lower leaves, the infestation spreads upward through the plant (Fig. 20c). The underside of heavily-infested leaves has a dense deposit of fine webbing (Fig. 20b). In cases of severe infestations the mites may invade and web sorghum panicles. Killed plants may subsequently lodge. Population density increases generally after sorghum head emergence.

Description and Biology. Banks' grass mites exhibit marked sexual dimorphism; the female is larger than the male, reaching an overall body length of 0.40-0.45 mm. After feeding, both sexes become a deep green, with the exception of the palpi and the first two pairs of legs, which remain light salmon (Fig. 20a). Eggs are laid on the underside of the leaves (about 50 per female) in webbing produced by the mites. Eggs are pearly white, spherical, and one-quarter the size of the adult. They hatch in 3-4 days. Six-legged nymphs are light-colored, and eight-legged nymphs become progressively dark green. The life cycle requires about 11 days at 27℃.

Control. Hot and dry weather usually increases mite populations. Control by natural enemies is often not effective. Varying degrees of success are achieved by chemical control (e.g., gusathion. rogor, kelthane, morestan). Resistance to pesticides has accounted for previous failures. Certain insecticides (e.g., DDT) can increase mite numbers.

Fig. 21

STEM FEEDER

a

b

c

Shoot Fly: *Atherigona soccata* (Rondani) (Muscidae: Diptera)

Distribution. The shoot fly is a widespread and damaging pest in practically all the sorghum-growing areas in the semi-arid tropics, but is not found in the Americas and Australia.

Symptoms. As a result of larval feeding the central leaf wilts and later dries up, giving the typical deadheart symptom (Fig. 21 b). The deadheart can be easily pulled out and, at the base, emits a bad smell. The young whitish yellow maggot feeds only on the decaying tissue. Normally the damage occurs from 1 week to about 1 month after emergence. If the attack occurs a little later, plants may produce side tillers that may also be attacked (Fig. 21c). Late sowing during the rainy season increases the likelihood of attack.

Description and Biology. The adult is a small, gray-colored fly (Fig. 21a) that deposits small (2 mm) white, cigar-shaped eggs (Fig. 21a), singly on the undersurface of the leaf. After hatching in 2-3 days, the maggots enter the plant through the whorl and destroy the growing point. Mature larvae are yellow and about 6 mm long (Fig.21a). The larval period lasts 8-10 days. Pupation takes place either in the plant or in the soil (Fig.21 a). The pupal period is also 8-10 days.

Control. The more promising control measures are the adjustment of sowing dates, high seeding rate, use of higher-yielding shoot fly resistant cultivars (Fig. 21 c) and the use of systemic insecticides (e.g., carbofuran).

Fig. 22

STEM FEEDER

a

b

c

Spotted Stem Borer: *Chilo partellus* (Swinhoe) (Pyralidae: Lepidoptera)

Distribution. The pest is very important and common in East Africa, the Indian subcontinent and the Far East, but not in West Africa. Several species attack sorghum but *C. partellus* is by far the most important.

Symptoms. The first indication that a plant is infested is the appearance of small elongated windows in young whorl leaves where the larvae have eaten the upper surface of the leaf but have left the lower surface intact as a transparent window (Fig. 22b). Then the plant may become very ragged in appearance as the severity of attack increases (Fig. 22b). Subsequently larvae bore into the stem and shot-holes appear in whorl leaves (Fig. 22c). Deadhead symptoms (Fig. 23a) then develop in younger plants. After head emergence the stalk just below or on the panicle is often bored, resulting in breaking of the panicles or complete or partial chaffy seeds (Fig. 23b). There is often extensive tunnelling of the stem (Fig. 23d). The borer attacks all parts of the sorghum plant except roots.

Fig. 23

STEM FEEDER

a

b

c

d

Description and Biology. The moth is medium-sized and straw-colored (Fig. 22a). A female lays nearly 500 eggs in masses of 10-80 on the undersurface of a leaf, often near the midrib. The eggs are flatfish and oval and tend to overlap like fish scales (Fig. 22a). They hatch in 4-5 days. The larval period lasts from 19 to 27 days. Pupation (Fig. 22a) takes place inside the stem and the adults emerge in 7-10 days through the larvae's entry holes (Fig. 23c). During the dry season the last instar larvae enter into diapause. The diapausing larvae can be found in stubbles and stalks remaining in the field. As the rainy season starts the diapause is broken and pupation takes place, giving rise to the 1st generation of adults.

Control. Several parasites and predators are known to suppress pest density. Plowing up and destroying the stubble after harvest is strongly recommended. Early planting with a high seed rate and removal of affected plants is advantageous. Chemical control with endosulfan or carbaryl is effective.

Fig. 24

STEM FEEDER

a

b

c

d

Maize Stalk Borer: *Busseola fusca* (Fuller) (Noctuidae: Lepidoptera)

Distribution. This is an important pest of sorghum in Africa.

Symptoms. Young larvae feed on leaves. More mature larvae bore into the stems and produce deadhearts. In severe cases of infestation, plant growth is retarded and flowering and grain production are reduced seriously. In general, symptoms of early feeding, deadhearts and stem tunnelling are similar to those of *Chilo partellus* damage (see Figs. 22 and 23).

Description and Biology. Eggs are laid in groups of 30-150 on the inner surface of leaf sheaths (Fig. 24b). About 400-1000 eggs are laid by each female during the 5-6 days of her life. The incubation period is 5-7 days. Newly hatched larvae remain in clusters under the leaf sheath. They disperse the following night and begin to feed on young leaves in the whorl. The larvae undergo 6-7 instars, and measure 35-45 mm when fully grown (Fig. 24c). They have buff to purple-brown bodies and a brown head. The larval period is 24-36 days. Larvae pupate in the plant stem (Fig. 24d) and cut an exit hole for the adult prior to pupation. The adults (Fig. 24a) emerge in 9-12 days and exhibit a wide variation in color. Usually 3 generations are produced per year. The 3rd-generation larvae enter into diapause with the onset of the dry season and complete their development in 6-7 months.

Control. Destruction of dry stalks and stubble by burning or plowing reduces borer density. Early sowing reduces infestation. Several parasites are known to attack the larvae and pupae. Carbofuran and carbaryl are effective insecticides.

Fig. 25

STEM FEEDER

a

b

c

Pink Borer: *Sesamia inferens* Walker (Noctuidae: Lepidoptera)

Distribution. This pest occurs in India, Sri Lanka, Pakistan, Burma, China, Japan. Indonesia, Malaysia, the Philippines, and Taiwan.

Symptoms. The larvae bores into the stem (Fig. 25c) and kills the central shoot, causing deadhearts. One larvae may attack several plants in its lifetime. The symptoms are similar to those of *Chilo partellus* (Figs.22 and 23).

Description and Biology. The adult moth is fawn-colored, with dark brown streaks on the fore wings and white hind wings (Fig. 25a). The female lays about 150 eggs that are arranged in two or three rows between the leaf sheath and the stem of the host plant. The eggs are creamy-white and hemispherical, about 0.7 mm in diameter, with fine ridges running longitudinally from the upper pole. As they approach hatching the color changes to brownish, and finally to gray. A female moth may lay up to 400 eggs. Hatching normally takes place in 7 days, but it may be extended during the winter or dry season. The fully grown larvae (Fig. 25b) measures about 25 mm and is pale yellow with a purple pink tinge and a reddish-brown head. The larval period normally lasts for 25 days but in cold months it may be extended to 75 days. Pupation occurs in the larval tunnel in the stem (Fig. 25c) and the adult emerges in 12 days. One generation may take 6-7 weeks.

Control. Control measures are the same as those for *Chilo partellus.*

Fig. 26

STEM FEEDER

a

b

c

Pink Borer (Africa): *Sesamia calamistis* Hmps. (Noctuidae: Lepidoptera)

Distribution. This insect is widely distributed in Africa.

Symptoms. Early larval instars feed on leaves, especially the leaf sheaths, while later instars tunnel into stems through internodes. This feeding causes stem breaking and chaffy panicles. Panicles also can be attacked. (For symptoms see those for *Chilo partellus.* Figs. 22 and 23.)

Description and Biology. The adult moth is light beige, more or less striped with brown (Fig. 26a). There are considerable geographical differences in color and markings. Yellowish, subspherical eggs are laid between the leaf sheath and stalk in groups of up to 40. They hatch in 4-6 days and the larvae, after feeding on leaves, bore into the stem where they remain for about 2 weeks. At maturity, larvae are 30 mm long and 3.5 mm wide, with a brown head and a buff body that has pale pink dorsal markings (Fig. 26b). Pupation (Fig. 26c) takes place inside the stem and usually lasts for 10 days. Unlike *B. fusca* no diapause generation is produced and larvae survive on wild grasses or volunteer sorghum and millets.

Control. Careful weeding and clean cropping, especially the removal of food sources near the sorghum crop, help in control. For chemical control, see *Chilo partellus.*

Fig. 27

STEM FEEDER

a

b

Sugarcane Borer (Africa): ***Eldana saccharina*** **(Walker)** (Pyralidae: Lepidoptera)

Distribution. This stem borer occurs throughout Africa south of the Sahara.

Symptoms. The newly hatched larvae feed on the leaves, usually boring into the midrib. Fully grown larvae bore into the stems and cause deadhearts (see *Chilo partellus,* Fig. 23a). The larvae hang down by means of silken threads and are sometimes blown onto neighboring plants.

Description and Biology. The female normally lays eggs in batches of 2-200 (Fig. 27a) but, occasionally, single eggs are also laid. Each female lays 400-600 eggs in about 2 weeks. The incubation period is 5-7 days. The newly-hatched larvae are about 2 mm long and orange, gradually becoming dark gray as they feed (Fig. 27a). The larva is very active, producing large quantities of frass. It spins a tough cocoon from which it later emerges and continues feeding. Males have 6-7 larval instars and females 7-8. The larval period ranges from about 20 to 60 days. Pupation takes place in a tough cocoon inside the stem (Fig.27b). The pupa is reddish brown with a prominent dorsal ridge. The adult emerges in about 8-13 days.

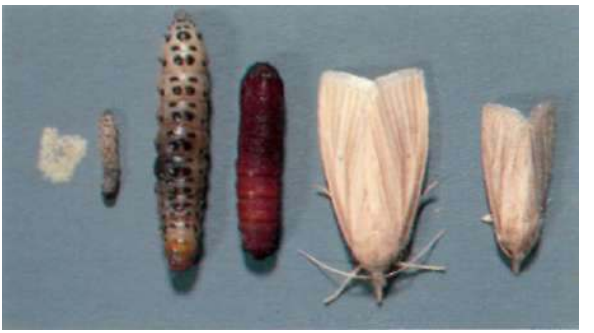
Control. Cultural control methods include the removal and burning of stubbles, burying crop residues, and the removal of volunteer and alternative hosts plants. Several natural enemies have been recorded. For chemical control, see *Chilo partellus.*

Fig. 28

STEM FEEDER

a

Diatraea saccharalis



b

Diatraea grandiosella

c

Diatraea lineolata

Sugarcane Borer (Americas): ***Diatraea saccharalis*** **(Fabricius)**
D. lineolata (Walker)
D. grandiosella (Dyar)
(Pyralidae: Lepidoptera)

Distribution. *D. saccharalis* and a number of other *Diatraea* species are widely distributed in North and South America. They occasionally infest sorghum but not as readily as they do sugarcane and maize, respectively.

Symptoms. Young larvae feed for a few days on leaves or at the leaf axis and then tunnel into stalks. Larvae bore up and down the pith of the stalk and may cause plants to lodge. Boring by the larvae in the peduncle of sorghum often causes the panicle to break. (See *Chilo partellus,* Fig. 23b).

Description and Biology. The larvae of these species are superficially very similar (Fig. 28a-c). The fully grown larvae are about 25 mm long, white to yellow, and conspicuously spotted with rounded brown or black spots across most body segments. The head and thorax are brown. The spots are absent or faded on the overwintering larvae. The insects pass the winter as full-grown larvae in cells in crop stubbles. Pupation occurs in the spring and adults emerge a few weeks later. Females lay eggs in clusters on the leaves of the host (Fig. 28a-c). Eggs are elliptical to oval, flattened, and they overlap like fish scales. They hatch in 3-7 days. The larval stage lasts about 25 days and the pupal stage about 10. There are 1-3 generations annually.

Control. Plowing and discing of stubble to eliminate overwintering larvae by exposure to cold temperatures is recommended. Early planting is encouraged. Chemical control is rarely justified. Monocrotophos is recommended as a foliar spray. Granular hand application to whorls of carbaryl 2.5% may be useful 2-3 weeks and 6 weeks after plant emergence.

Fig. 29

STEM FEEDER

a

b

Lesser Cornstalk Borer:

Elasmopalpus lignosellus (Zeller)
(Pyralidae: Lepidoptera)

Distribution. The lesser cornstalk borer is a sporadic pest of sorghum in the Americas.

Symptoms. Typical injury in young plants is characterized by tunnels in the plant at or slightly below the surface of the soil. Heavy infestations may cause loss of stand, stunting, and tillering. In old plants the injury in the stems is of a girdling nature near the ground. Consequently, plants are subject to stalk breakage. The presence of earthenlike silk-webbed tubes attached at the entrance of the tunnels into the plant is evidence of an infestation (Fig. 29b). These tubes are occupied by the larvae when they are not feeding in the plant (Fig. 29b).

Description and Biology. The moth is brownish-gray with a wing expanse of less than 25 mm. The larvae are slender, 20 mm long (Fig. 29a). The prevailing colors are light green or bluish-green, but there are faint longitudinal stripes and more prominent transverse bands of brown or reddish-brown. Winter is passed in a stalk burrow in the soil as larvae or pupae. Eggs are laid on the host plant and hatch in about 7 days. The larva becomes fully grown in about 2-3 weeks. The larvae have a distinctive habit of jerking and skipping when disturbed. The pupal stage lasts about 2-3 weeks.

Control. Cultural control practices are usually adequate and include destroying overwintering insects though the elimination of crop debris by plowing in late fall or early winter. Early planting and fertilization are advocated as a means of producing vigorous plant growth and tolerance to an infestation. Cultivation to destroy weeds before planting is recommended. For chemical control carbofuran is recommended.

Fig. 30

STEM FEEDER

Sugarcane Rootstock Weevil:

Anacentrinus deplanatus (Casey)
(Curculionidae: Coleoptera)

Distribution. Sporadically, especially during dry years, the sugarcane rootstock weevil infests sorghum in southwestern USA.

Symptoms. The weevil feeds on young sorghum plants and the rootstock, and injury is noticeable but is not as serious as that caused by the larva. The larva tunnels into the sorghum stalk below and just above the surface of the soil. (See Fig. 30 that illustrates light to heavy infestation.) The tunnels resemble those made by other borers, except that they are much smaller. The larva is often found at the nodes and near the outer surface of the stalk. Its feeding is often responsible for the lodging of sorghum plants, and a drought-stressed appearance. Exit holes and feeding tunnels provide favorable entrance-points for diseases such as charcoal rot.

Description and Biology. The weevil is dark brown or black and about 9.5 mm long and 3 mm wide. Larvae are white legless grubs about 5 mm long when fully grown. Pupae are white until shortly after emergence, when they take on a brownish tint. Eggs are creamy white, oval in shape, 0.29 mm in diameter, and 0.48 mm long. The female uses her mouthparts to make a small puncture in the plant in which the egg is deposited and concealed. Each female lays 16 eggs that hatch in 6 days. The larval and pupal stages develop in 25 and 10 days, respectively. A generation is completed in 41 days. The insect overwinters as an adult in ground trash. It infests wild grasses during early spring and later moves to sorghum.

Control. Controls are rarely justified.

Fig. 31

HEAD FEEDER

a

b

Sorghum Midge:

Contarinia sorghicola (Coquillett)
(Cecidomyidae: Diptera)

Distribution. The sorghum midge is probably the most widely distributed of all sorghum insect pests. It occurs in nearly all regions of the world where the crop is grown, except Southeast Asia.

Symptoms. Damage to sorghum is caused by larvae feeding on the ovary, preventing normal grain development and resulting in a "blasted panicle" (Fig. 31 b).

Description and Biology. The adult is 1.3-1.6 mm long, with a yellow head, brown antennae and legs, an orange-red thorax and abdomen, and grayish hyaline wings (Fig. 31a). Females each lay about 75 eggs in flowering spikelets during their short 1-day life. Eggs are cylindrical in shape, 0.1 x 0.4 mm, and hatch in 2-3 days. Initially, larvae are colorless, but, when fully grown, they are dark orange. Larvae complete development in 9-11 days, pupating beneath the glume. Shortly before adult emergence the pupa works its way towards the apex of the spikelet until about three-quarters of the pupal length protrudes from the tip. When the adult emerges the white pupal skin remains at the tip of the spikelet. The pupal period is completed in 3 days. A generation is completed in 14-16 days. Diapause occurs during the larval stage in a cocoon within a spikelet. The insect's rapid developmental cycle permits 9-12 generations to occur during one season and results in the build-up of high infestations when sorghum flowering times are extended by a wide range of planting dates or maturities.

Control. Early and uniform planting of sorghum over large areas is the most widely accepted method of reducing midge damage. Multiple insecticide applications directed at adults are used primarily to reduce losses in late plantings. Disulfoton and phosalone are recommended. The economic threshold level in the USA for chemical control is one adult per panicle during flowering. Midge-resistant sorghum hybrids are available in the USA.

Fig. 32

HEAD FEEDER

a

b

c

Bollworm: *Heliothis armigera* (Hubner)
(Noctuidae: Lepidoptera)

Distribution. This pest is widely distributed in Southeast Asia, Africa, Australia, New Zealand, and southern Europe.

Symptoms. The larva infests the sorghum head (Fig. 32c) where it feeds on the developing grain. It also feeds on the tender whorl leaves.

Description and Biology. The spherical yellowish eggs are laid singly on the young sorghum heads. The incubation period is 3-4 days. The young larvae are whitish-green. Fully-grown larvae vary from almost black, brown or green to pale yellow or pink with light and dark stripes. Fully-grown larvae are about 40 mm long (Fig. 32b). The larval period lasts from 18 to 25 days. It pupates in the soil in an earthen cell and emerges in 1-2 weeks. The moth is large and brown or gray with specks that form a V-shaped mark on the fore wings (Fig. 32a). The hind wings are dull-colored, with a black border.

Control. A large number of parasites and predators, including birds, attack this pest. Natural cannibalism and bacterial and viral diseases also tend to reduce populations. Plowing the field is useful in exposing the pupae to heat and predators, thus preventing the emergence of adults. Crop rotation is extremely useful. Open-type sorghum panicles are less affected as the larvae on them are exposed to predacious insects and birds. Endosulfan and carbaryl are effective insecticides for small larvae.

Fig. 33

HEAD FEEDER

a

b

Corn Earworm: *Heliothis zea* (Boddie) (Noctuidae: Lepidoptera)

Distribution. The corn earworm is widely distributed in the Americas.

Symptoms. Larvae, which hatch from eggs laid on the leaves, migrate to the whorl and feed on the tender, folded leaves. When the damaged leaves unfold, they are ragged, but this injury usually does not reduce yields greatly. Panicle infestations are of greatest concern because the larvae, like *H. armigera,* feed on the developing grain.

Description and Biology. Moths (Fig. 33a) are about 19 mm long with a wingspan of 38 mm. They vary from dusty yellow, olive green, or gray to reddish-brown. Females are active in the evening and live about 12 days. Each may deposit from 350 to 3000 eggs. Eggs are flattened spheres, prominently ribbed and 1.2 mm in diameter. When deposited they are white, but soon darken and hatch in 3-5 days. White, newly hatched larvae grow rapidly and become variously colored, ranging from pink, green, or yellow to almost black. Many are conspicuously striped. Down the side there is a pale stripe edged above with a dark one, and down the middle of the back there is a dark stripe divided by a narrow white line that makes the dark line appear doubled. Fully-grown larvae are robust and 38-50 mm long (Fig. 33b). Pupation occurs in the soil. The pupa is the overwintering stage. It is about 19 mm long, initially green but subsequently brown.

Control. Natural limiting factors include cannibalism among larvae, predators, parasites, and diseases. Early-planted sorghum and sorghum with open (loose) panicles are usually less heavily infested. Insecticidal control is justified at two small larvae per panicle. Endosulfan is recommended.

Fig. 34

HEAD FEEDER

a

b

Sorghum Webworm: *Nola sorghiella* (Riley) (Nolidae: Lepidoptera)

Distribution. The sorghum webworm is an occasional pest of sorghum during the late season in the humid south of USA and in Central America.

Symptoms. Young larvae feed on developing floral parts. Older larvae gnaw circular holes in the seed, which is usually only partly consumed (Fig. 34b). The larvae do not spin webs over the panicle but, when disturbed, young larvae often suspend themselves by spinning a fine silken strand.

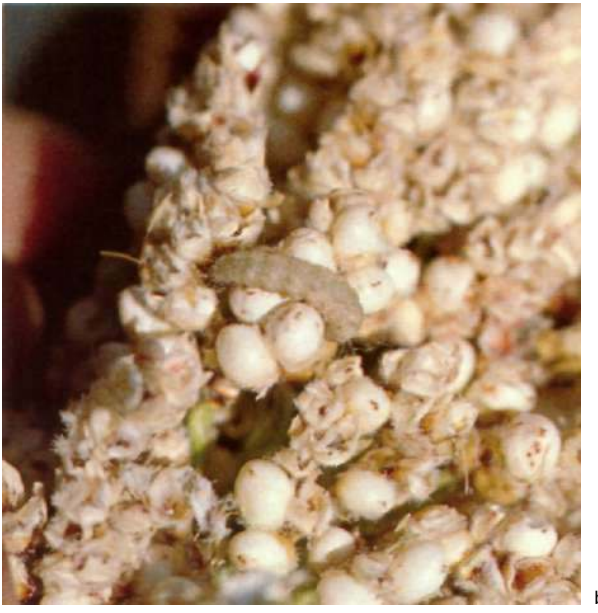
Description and Biology. The adult is a small whitish moth with a wing expanse ranging from 12 to 16 mm. Moths are active at night, laying about 100 eggs singly but rather securely fastened to the flowering parts or seed of sorghum. The eggs are roundish to broadly oval in outline and flattened dorsoventrally. They are 0.46 mm in diameter and 0.26 mm in height. Eggs are white at first but turn deep yellow to brown before hatching in 3-4 days. Mature larvae reach 12 mm in length in 13 days. They are somewhat flattened, yellowish or greenish-brown and marked with four longitudinal reddish to black dorsal stripes. Densely-spaced spines and long hairs cover the body (Fig. 34a). The pupa, within a cocoon (Fig. 34a), is reddish brown, rather slender and subcylindrical and the stage lasts 6 days. Adults live about 5 days. A generation requires about a month. Diapause occurs in the larval stage, hidden on the host plant.

Control. Cultural controls include early planting and the use of sorghum with open (loose) panicles. Most insecticides control small webworms, and applications are worthwhile at five young larvae per panicle. Endosulfan and carbaryl are recommended.

Fig. 35

HEAD FEEDER

a



b

Earhead Webworm: *Nola analis* (Wileman & West) (Nolidae: Lepidoptera)

Distribution. This panicle caterpillar is of minor importance in Africa and Asia.

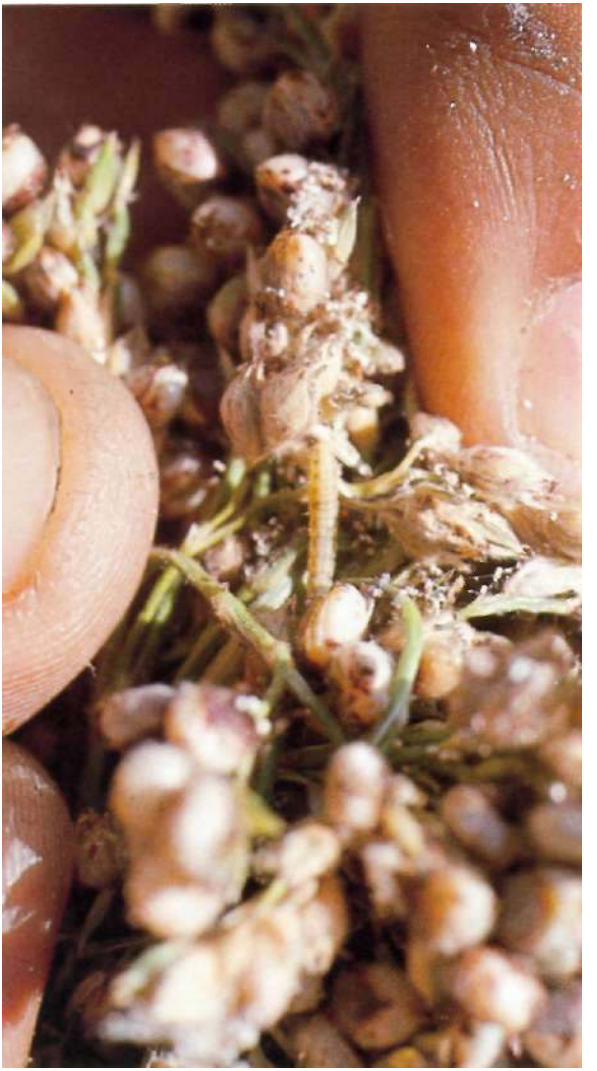
Symptoms. The larva feeds on the grain in the head (Fig. 35b).

Description and Biology. Eggs are laid on spikelets and grains of the panicle and are round and creamy white in color. Incubation requires 2-3 days. The young larva is dark gray with hairs on its body. The fully-grown larva is about 13.5 mm long (Fig. 35a). The larval period is 2 weeks. The larvae remain inside the webs formed from excreta and silken threads. Pupation takes place inside the webs. The pupa is short and conical and fully covered with silken webbing. The pupal period is about 8 days. The adults are small and white. There are two prominent black spots on the fore wings in the middle near the anterior margin, and just behind these are two zigzag dirty white stripes that run vertically.

Control. Control measures are rarely necessary. Insecticides such as endosulfan or carbaryl may be used if required.

Fig. 36

HEAD FEEDER



Earhead (Christmas Berry) Webworm:

Cryptoblabes gnidiella (Milliere)
(Pyralidae: Lepidoptera)

Distribution. This pest is increasing in importance on hybrids and high-yielding cultivars of sorghum in India.

Symptoms. The larvae destroy the grain in the head (Fig. 36). They produce webs of silken thread that remain on and inside the head. Heavily infested heads may be covered with webbing.

Description and Biology. Creamy white, round or conical eggs are laid on the spikelets and on grains of fhe panicle. The incubation period is 3-4 days. The freshly-hatched larva is dirty white, with a brown head. The fully-grown larva is active, measuring about 12 mm in length, and is dark brown (Fig. 36). The larval period is 9-10 days. Pupation takes place inside the silken webs. The pupa is very short and brown. It is fully covered with silken threads that are secreted by the larva. The adult emerges within a week. The adult has dark gray fore wings and the hind wings, fringed with hairs on the anterior margin, are larger than the fore wings.

Control. Chemical controls are usually not required, but endosulfan may be used if necessary.

Fig. 37

HEAD FEEDER

Hairy Caterpillar: *Euproctis subnotata* (Walker) (Lymantriidae: Lepidoptera)

Distribution. This panicle caterpillar occurs occasionally in large numbers in India.

Symptoms. The larvae infest the sorghum head in large numbers and feed on hardening grains. But, in spite of the number of larvae found in a panicle, the damage caused to the grain is slight. The hairs of the larvae can cause skin irritation.

Description and Biology. Adults have brown fore wings with dark scales, and their color extends as two spurs across the yellow marginal area below the apex and to the center of the wing margin. The hind wings are yellow. Spherical transparent white eggs are laid in masses (6-24 eggs in each) and covered by orange-yellow hairs from the anal tuft of the female. The newly hatched larvae have a congregating habit that continues in the mature larvae. The hairy larva is dark brown with a wide yellow band dorsally on abdominal segments 1 to 7 and 9. A median orange-red line runs along the yellow band and a fine yellow band occurs on each side of the larva above the spiracular line (Fig. 37). Pupation takes place on the ground and also in the panicles. Egg, larval, and pupal stages last 5-7, 15-40, and 10-17 days, respectively.

Control. This insect is relatively minor in importance and controls are rarely required, but endosulfan or carbaryl may be used if necessary.

Fig. 38

HEAD FEEDER

Blister Beetle: *Mylabris pustulata* (Thunberg) (Meloidae: Coleoptera)

Distribution. Blister beetles of several species and genera attack sorghum in Asia and Africa.

Symptoms. They are general feeders on many kinds of plants. The adult beetles feed on flowers and tender panicles, preventing grain formation.

Description and Biology. The beetles are medium-sized, 12.5-25.0 mm long. They are conspicuously bright metallic blue, green, black, and yellow or brown (Fig. 38). When disturbed the beetles emit a fluid containing cantharidine that has irritant properties. The beetles have an unusual life cycle. The female lays a large number of eggs, often 2000-10,000 on the ground or in the soil. From these eggs, triungulin (long-legged) larvae hatch and attack other insect eggs. They feed upon the eggs and undergo hypermetamorphosis (different larval forms), then pupate and become adults.

Control. Blister beetles are usually minor in importance and control is seldom required. Insecticides such as carbaryl and fenthion are recommended for the control of adults.

Fig. 39

HEAD FEEDER

a

b

C

Earhead Bug: *Calocoris angustatus* (Lethiery) (Miridae: Heteroptera)

Distribution. This is a very serious pest of sorghum in certain parts of India. This and other species of panicle-feeding bugs infest sorghum in Africa.

Symptoms. Both nymphs and adults infest the panicles as soon as they emerge from the boot leaf and suck sap from the developing grain. Consequently, grain attacked in an early stage of development (Fig, 39b) is shriveled, reducing crop yield. Older grain shows distinct feeding punctures (Fig. 39c) that reduce grain quality.

Description and Biology. The adult female is about 5 mm long, a little more than 1 mm in width, and yellowish green (Fig. 39a). It inserts long (about 1.5 mm) cigar-shaped eggs generally under the glumes or between the anthers of the sorghum florets. Each insect lays between 150 and 200 eggs. The eggs normally hatch in less than a week. Within a period of a little over 2 weeks, the tiny first-stage yellow and orange-red nymphs develop to the adult stage through 5 instars. The life cycle from egg to adult occupies less than 3 weeks. At least 2 generations of the bug can feed on the same crop when the panicles do not ripen at the same time.

Control. A reduviid bug and a lygaeid bug are predacious on the insect. Open-type heads are less affected than compact ones. Carbaryl dusts can usually control the pest.

Fig. 40

HEAD FEEDER

a

b

Sap-sucking Bug: *Dolycoris indicus* (Stal)
(Pentatomidae: Heteroptera)
Spilostethus sp
(Lygaeidae: Heteroptera)

Distribution. *D. indicus* is widely distributed in Asia while *Spilostethus* sp. occurs in Africa and Asia.

Symptoms. Both *D. indicus* and *Spilostethus* sp. suck sap from the developing grains, causing them to shrivel.

Description and Biology. The body surface of D. *indicus* is dull (not shining) brownish or yellowish with black punctures, small in size (length 10 mm and width 6 mm) (Fig. 40a). The *Spilostethus* bug is reddish-yellow with black markings (Fig. 40b). Not much information about the life cycle is available.

Control. Both insects are of minor importance and controls are not required.

Fig. 41

Panicle-feeding Bugs

False Chinch Bug: *Nysius raphanus* (Howard)
(Lygaeidae: Heteroptera)

Leaf-footed Bug: *Leptoglossus phyllopus* (L.)
(Coreidae: Heteroptera)

Southern Green Stink Bug: *Nezara viridula* (L.)
(Pentatomidae: Heteroptera)

Rice Stink Bug: *Oebalus pugnax* (Fabricius)
(Pentatomidae: Heteroptera)

Conchuela Stink Bug: *Chlorochroa ligata* (Say)
(Pentatomidae: Heteroptera)

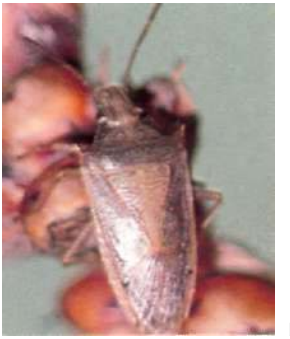
Distribution. *N. raphanus* and *L. phyllopus* are present in Africa, while *N. viridula* has a worldwide distribution. *O. pugnax* and C. *ligala* are restricted to the Americas.

Symptoms. Damage by this group of insects results from their sucking of sap from developing grain and rachis branches (Fig. 41). Often the damaged seeds are infected with fungi that cause the seed to turn black and results in further deterioration of quality. Damaged seeds rarely develop fully and are considerably smaller, softer, and lighter in weight than undamaged seed, and are subject to loss during harvest. The extent of damage depends on bug density, grain development stage when infestation occurs, and the duration of the infestation. These characteristics differ, depending on species.

Fig. 42

HEAD FEEDER

a



b

c

d

e

Description and Biology

The false chinch bug (Fig. 42d) superficially resembles the chinch bug but its color is more uniform and ranges from grayish to brown. It is 3 mm long. The insect occasionally migrates in large numbers from wild hosts to sorghum fields, but infestations are usually concentrated in small areas.

The leaf-footed bug is brown, oblong, and about 20 mm long. A white band extends across the fore wings (Fig. 42e). The tibiae of the hind legs are dilated or leaf-like. Eggs are laid in clusters of 15-35 in definite rows. Nymphs are reddish.

The southern green stink bug is a large green species, typically shield-shaped, and 19 mm long (Fig. 42a). In the spring overwintered females deposit 300-500 eggs in clusters of 30. Hatching occurs in about 7 days and the adult stage is reached in about 6 weeks. Repeat generations occur at 5- to 6-week intervals. Adults live 40-60 days or all winter.

The rice stink bug is straw-colored, shield-shaped and 12 mm long (Fig. 42b). Some 10-47 light green, short, cylinder-shaped eggs are laid and arranged in a cluster of two rows. Egg-hatching occurs after about 5 days. Nymphs require 15-28 days to become adults.

The conchuela stink bug varies in color from dull olive or ash gray to a green, purplish pink, or reddish brown (Fig. 42c). The most characteristic markings are an orange-red band along the lateral margins of the thorax and the margins of the wings, and a spot of the same color on the back at the base of the wings.

Control. Infestation in sorghum normally occurs when other hosts become unacceptable or unavailable. Early planting is advantageous in avoiding bug damage. If chemical control is required carbaryl dust is recommended.

Fig. 43

HEAD FEEDER

a

b

Iridescent Blue-green Cotton Bug:

Calidea dregii (Germar)

(Pentatomidae: Heteroptera)

Distribution. Several species of blue-green cotton bugs are spread over East, West, southeast and southern Africa.

Symptoms. Both nymphs and adults suck the contents of milky grains of sorghum, resulting in shriveled grains (Fig. 43b). Excretas appear as white spots on the leaves.

Description and Biology. The blue-green cotton bug is conspicuous because of its blue and green colors (Fig. 43a). It breeds on sorghum. The spherical eggs, 1 mm in diameter, are laid in batches of up to 40 in closed spirals. They are white, and turn red as they develop. The nymphs resemble the adults in color and appearance. The life cycle is completed in 23-56 days, depending on the temperature.

Control. In severe attacks the pest can be controlled with insecticides, such as endosulfan.

Fig. 44

PREDATOR/PARASITE

a

b

Ladybird Beetle: Several species
(Coccinellidae: Coleoptera)

Several species and genera of ladybird beetles are predators of a number of sorghum insect and mite pests. As a group, adults are semi- or hemispherical insects (Fig. 44a) but, depending on species, are orange, red, tan, gray, or black, and spotted or marked with contrasting colors of red, yellow, black, or white. They are rather small, varying in length from 1.5 to 6.0 mm. Ladybird beetles are sometimes confused with certain leaf beetles. The larvae are elongate, tapering posteriorly (Fig. 44a). Their general color is dark with bright markings and their bodies are covered with spines.

Ladybird beetles hibernate as adults, often in large numbers, in places affording protection and reasonably dry conditions. When a larva has completed its development it attaches itself to some part of the plant or to some nearby object, and pupates. It pupates within the slit larval skin or works this skin downward to the end of the abdomen. Females lay 200-500 yellow eggs in clusters (Fig. 44b). The length of a life cycle varies with the species and temperature, but it is usually 3-4 weeks in duration.

With few exceptions, both adults and larvae are beneficial. They are predacious on aphids, scale insects, spider mites, eggs of a number of insects, and small larvae of many pests. Since ladybird beetles reproduce rapidly and are voracious feeders, they are among the most beneficial of all predators. Larvae have been observed to devour 11 -25 aphids daily, and adults 16-56.

The example shown in the figures is *Hippodamia convergens* (Guerin-Mandeville).

Fig. 45

PREDATOR/PARASITE

a

b

Syrphid Fly: Several species
(Syrphidae: Diptera)

The adults of this very large group are also known as flower flies, hover flies, and sweat flies. Many are brightly colored and resemble various bees or wasps (Fig. 45a). They feed upon nectar and pollen of flowers and are of value as pollinators of many plants. Many hover motionless in the air except for the beating of the wings; others fly with a buzzing sound like that produced by bees.

Syrphid fly larvae, as a group, vary considerably in habits and appearance. Many are predacious on aphids. They vary in length from 6 to 19 mm when fully grown. Many are highly-colored with varying shades of yellow, pink, green, or brown marked with black or white (Fig. 45b). Their bodies are pointed at the head end, and are blunt or broad at the tail end and somewhat depressed. They are elongate, legless, and slug-like.

The larvae are common among aphid colonies, moving slowly over the surface of the plant, grabbing aphid after aphid with their pointed jaws, raising them in the air and slowly sucking out all the body contents, finally discarding the empty skin. Larvae often destroy aphids at the rate of one per minute over a considerable period of time. Adults lay glistening-white elongate eggs among groups of aphids.

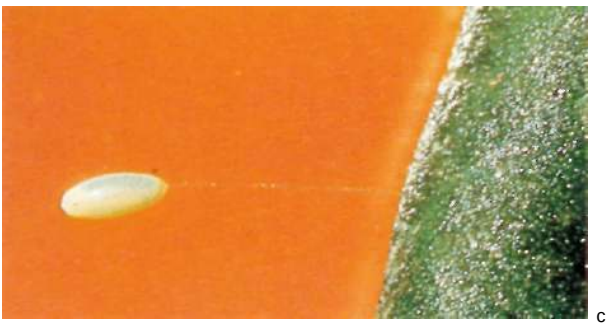
The example shown in the figures is *Allograpta obliqua* (Say).

Fig. 46

PREDATOR/PARASITE

a

b



c

Common Green Lacewing: Several species (Chrysopidae: Neuroptera)

The lacewing flies of several species are common predators of sorghum insect and mite pests. Their larvae, called aphis lions, are among the more important beneficial insects. Larvae feed voraciously upon aphids, thrips, mites, small larvae, and other soft-bodied insects or eggs. The adults are recognized by their usually greenish or yellowish-green color, delicate lace-like wings, and have shining golden eyes in some species (Fig. 46a). They are rather delicate, soft-bodied insects and are about 25 mm long. The larvae have elongate spindle-shaped mandibles (Fig. 46b). These characteristic mandibles readily distinguish them from ladybird beetle larvae. The larvae are very active in seeking their prey and obtain their food by puncturing the body of the victim and extracting the body fluids with their unusual mouth-parts.

Lacewings usually hibernate in their silken cocoons as pre-pupae. Some are reported to overwinter as adults. Adults emerge in the spring when the weather becomes sufficiently warm. Eggs are laid on silken stalks which project about 12 mm above the surface of the leaves or stem to which they are attached (Fig. 46c). It is thought that the stalks protect the eggs from their natural enemies, particularly larvae of their own kind. Females probably lay an average of several hundred eggs. Eggs hatch in about a week. Larvae are voracious feeders upon aphids and other small insects. At the end of the 3rd instar the larvae seek sheltered places on leaves or elsewhere and spin cocoons in which they pupate. The larval period averages between 2 and 3 weeks; the pupal period is of similar duration. The completion of a generation averages about 40 days; there may be 5 or 6 generations annually in warm climates. The example shown in the figures is *Chrysopa carnea* (Stephens).

Fig. 47

PREDATOR/PARASITE

a

b

Predacious Bugs

Minute Pirate Bug: *Orius tristicolor* (White)
(Anthocoridae: Heteroptera)

Common Damsel Bug: *Nabis americoferus*
(Carayon)
(Nabidae: Heteroptera)

Large Big-eyed Bug: *Geocoris bullatus* (Say)
(Lygaeidae: Heteroptera)

These three predacious bug species are representative of several species within each group that are commonly found feeding on sorghum insect and mite pests in the semi-arid tropics. Species vary according to geographic location, but appearance, habits, and biology are similar.

Adult minute pirate bugs or flower bugs are small, usually about 2 mm long and are usually black with white markings (Fig. 47a). The elongated, thickened, basal portion of the front wings is yellowish-white and is marked by a large triangular black spot at the tip; the membranous part of the wing is white. The insect bears a superficial resemblance to the chinch bug, but is much smaller. The tiny nymphs are yellowish (Fig. 47b). Adults overwinter in trash. Eggs are deposited in plant tissues. Several generations are completed each season. They feed on insect eggs, newly-hatched larvae, nymphs, spider mites, thrips, and other small insects.

Fig. 48

PREDATOR/PARASITE

a

b

Members of damsel bug family are rather small, usually about 8 mm long, with the body somewhat narrowed anteriorly (Fig. 48a). The front legs are armed on the inner face with a double row of short spines and are capable of closing tightly to form a grasping organ with which prey is held. Some species have both long- and short-winged forms. Common species are yellowish-brown. These insects hide among foliage or in flowers and capture aphids, caterpillars, and similar insects on which they subsist.

The big-eyed bugs comprise one of the fewgroups of lygaeids that are predacious. The front legs of the members of this group are raptorial (equipped for capturing prey). These insects are small, about 5 mm long. They are distinguishable by their large protruding compound eyes (Fig. 48b). Their bodies are dark with whitish wings. Both adults and nymphs are predacious on various small insects.

Fig. 49

PREDATOR/PARASITE

a

b

c

Predacious Beetles (Ground Beetles): Many species (Carabidae: Coleoptera)

Ground beetles constitute a large family of many species commonly found running on the ground in search of prey or hiding under stones, logs, and rubbish. Most members of this family are beneficial, preying on other insects in both the larval and adult stages.

The bodies of adults are somewhat flattened; they have long legs and are usually dark in color, as in the case of the ground beetle (Fig. 49c). Some, however, are blue, brown, or green. A few have strikingly violet or green wing covers bordered with reddish-brown, and the body is green, blue, and copper. The size of adults varies considerably, depending on species; most range from 10 to 25 mm in length. The wing covers of most species are marked with rows of longitudinal ridges and punctuations.

The larvae of most ground beetles are predacious and largely nocturnal. Fully-grown larvae vary considerably in length, from 10 to 45 mm. Their bodies are elongate, and slightly flattened. The color is usually dark brown (reddish) or near black, with some exhibiting different shades of yellow. Mandibles are large and sickle-shaped. Larvae are slightly tapered to the tail, which terminates two bristly, hair-like or spine-like processes.

Ground beetles feed primarily on soft-bodied insects and small animals found in, on, or near the ground. Common hosts are cutworms, leaf-feeding caterpillars, grubs, maggots, naked pupae, snails, and soil worms.

Red cross beetles (Fig. 49b) and hooded beetles (Fig. 49a) are also predators.

Fig. 50

PREDATOR/PARASITE

a

b

Insect Parasites

Tachinid Flies: (Tachinidae: Diptera)
Ichneumonid Wasps: (Ichneumonidae: Hymenoptera)
Braconid Wasps: (Braconidae: Hymenoptera)
Chalcid Wasps: (Chalcidae: Hymenoptera)

The most valuable insect parasites are contained in the groups listed above. Parasites live in or on one host individual which does not die until the parasite completes its development.

Tachinid flies of many species resemble, superficially, an overgrown house fly, being very bristly, usually grayish, brownish, or black-mottled (Fig. 50a). The adults rest on foliage or on flowers upon which they feed. Adults lay eggs glued to the host or laid on foliage where the host insect may ingest them; or hatched larvae are deposited on or in the victim. Larvae feed on the host contents and adults emerge from the pupae before or just after the host dies.

Ichneumonid wasps include a large number of species and are very widely distributed. Much variation is found in size, form, and markings of the adults. Most are somewhat wasp-like in appearance and many of the females have very long ovipositors, often longer than the body (Fig. 50b). Most of these wasps are internal parasites of the immature stages of the host. The parasite may complete its development in the stage of the host in which the egg is laid, or in a later stage. There are few groups of insects that are not parasitized by some ichneumonids.

Fig. 51

PREDATOR/PARASITE

a

b

Braconid wasps are another large group of parasitic insects. They parasitize a wide range of insects but chiefly aphids and the larvae of moths, beetles, and flies. The adults are all relatively small (rarely over 15 mm long) and a great many are stout-bodied (Fig. 51 a). The habits of the braconids are similar to the ichneumonids except that many of them pupate in silken cocoons on the outside of the body of the host and others spin silken cocoons entirely apart from the host. Aphids are often parasitized by members of this group. Parasitized aphids swell and their bodies harden (into mummies). Adult wasps emerge through circular holes in the aphids' skin.

Chalcid wasps are usually quite small (2 mm) and in general are metallic blue or green (Fig. 51 b). Many species live inside minute insects or the eggs of scale insects, aphids, caterpillars, and flies.

Fig. 52

STORAGE PEST

a

b

Maize Weevil: *Sitophilus zeamais* (Motschulsky)
Rice Weevil: *Sitophilus oryzae* (L.)
(Curculionidae: Coleoptera)

Distribution. These weevils are the most destructive insect pests of stored grain in the world. They infest a very large variety of stored grains and are cosmopolitan in distribution, but are much more injurious in warm humid countries.

Symptoms. Both the adults and larvae feed on grain, which may often be damaged beyond use (Fig. 52b).

Description and Biology. The adult weevils are reddish brown, about 4 mm long, and have four light reddish or yellowish spots on the wings (Fig. 52a). Weevils infest the grain both in the field and in storage. The adult female bores a hole in a kernel, deposits a single egg and covers it with a gelatinous fluid. A female may lay as many as 300-550 eggs in 4-5 months. The incubation period is 3 days. The grub is legless, short, stout, and whitish with a brown head. Larvae mature in 3-6 days. The longevity of the adult is 4-5 months. There may be 5-7 generations in a year.

Control. Grain should be stored in a dry, clean condition, in insect-proof containers. If the grain moisture content is less than 9% the insect is unable to breed. If keeping the grain dry is not practicable, fumigation may be the only feasible protection.

Fig. 53

STORAGE PEST

Flat Grain Beetle: *Cryptolestes pusillus* (Schonherr) (Cucujidae: Coleoptera)

Distribution. It has worldwide distribution.

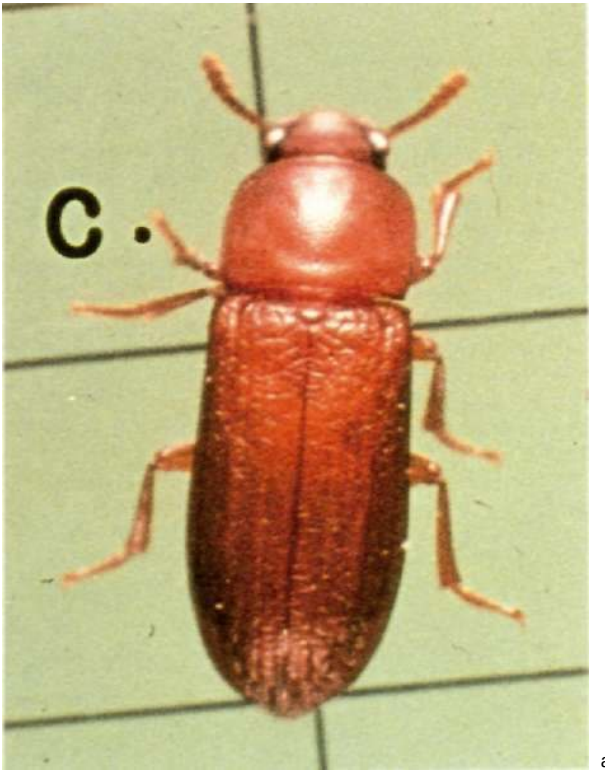
Symptoms. The beetle is not a primary pest of stored grain, and the adult is apparently unable to survive in sound, uninjured grain. It follows up the attack of the more vigorous grain pests and is frequently found in enormous numbers associated with the rice weevil. It is a scavenger by nature and often infests grain and meal that is out of condition.

Description and Biology. The flat grain beetle is one of the smallest beetles commonly found in stored grain. It is a minute, flattened, oblong, reddish-brown beetle about 2 mm long, with elongate antennae about two-thirds as long as the body (Fig. 53). The small white eggs are placed in crevices in the grain or dropped loosely. The larvae are particularly fond of the germ, and in infested grain many kernels will be found uninjured except for the removal of the germ. The larvae also feed on dead insects. When fully grown, the larvae form cocoons of a gelatinous substance to which food particles adhere. They transform to the pupal stage in these cocoons and later emerge as adults. This insect may complete its development from egg to adult in about 5-9 weeks, depending on the temperature.

Control. See the advice given for maize and rice weevils.

Fig. 54

STORAGE PEST



a

b

Confused Flour Beetle: *Tribolium confusum* (du Val) (Tenebrionidae: Coleoptera)

Distribution. The beetle is generally distributed all over the world. It is a secondary feeder. It is found in granaries, mills, warehouses, and wherever grain or grain products are stored.

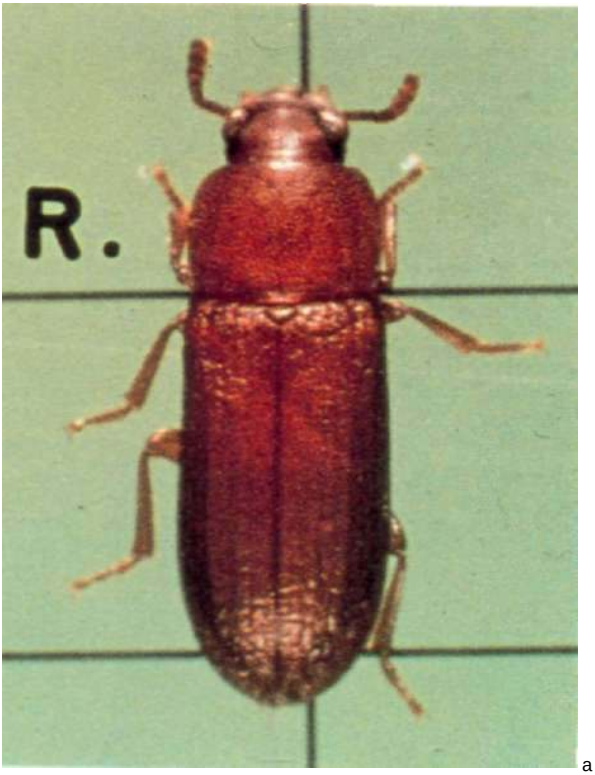
Symptoms. These larvae feed on flour or other material such as grain dust and the broken surfaces of grain kernels.

Description and Biology. The confused flour beetle is a shiny, reddish-brown beetle (Fig. 54a) about 3.5 mm long, flattened and oval. The head and upper parts of thorax are densely covered with minute punctures; the wing covers are ridged lengthwise and sparsely punctured between the ridges. The average life of the beetles is about 1 year, but some have been known to live as long as 45 months. The females lay an average of about 450 eggs each. The small white eggs are laid loosely in flour or other food material in which the adults are living. They are covered with a sticky secretion and thus become covered with flour or meal, and readily adhere to the sides of sacks, boxes, and other containers, so that fresh material placed in them is rapidly infested. The eggs hatch after 5-12 days into small worm-like larvae, slender, cylindrical, and wiry in appearance. When fully grown, they are about 4.5 mm long, and are white, tinged with yellow (Fig. 54b). They then transform to small naked pupae. At first white, the pupae gradually change to yellow and then brown, and shortly afterwards transform to beetles. The period from egg to adult in summer averages about 6 weeks under favorable weather conditions, though the life cycle is greatly prolonged by cold weather, as is true of all grain pests.

Control. See *T. caslaneum* (following page).

Fig. 55

STORAGE PEST



a

b

Red Flour Beetle: *Tribolium castaneum* (Herbst) (Tenebrionidae: Coleoptera)

Distribution. This beetle is a cosmopolitan insect found infesting stored grain, seeds, flour, dried fruits, nuts, museum insects, and stuffed animal specimens.

Symptoms. Adult beetles can be readily observed by the tunnels they construct when they move through flour or other granular food products. This pest is particularly serious in processed rice and wheat products. When attack is severe, these products turn grayish-yellow and become moldy, with a pungent smell.

Description and Biology. The adult is about 3-4 mm long, rather flat, oblong, and chestnut brown (Fig. 55a). It lays up to 450 eggs in the stored produce. The egg is minute, cylindrical, and white. The incubation period lasts for 5-12 days. The yellowish-white cylindrical grub is covered with fine hairs and becomes fully grown in 27-29 days (Fig. 55b). It has a naked pupa and adults emerge in 3-7 days. Depending on weather conditions there may be 4-7 generations a year and 1 generation may take 1-4 months. The optimum conditions for the development of this pest are 35℃ and 70% relative humidity.

Control. Exclusion of insects by storing products in sealed containers provides effective control. Fumigants are also effective.

Fig. 56

STORAGE PEST

a

b

c

Lesser Grain Borer:

Rhyzopertha dominica (Fabricius)
(Bostrichidae: Coleoptera)

Distribution. This beetle pest is cosmopolitan in its distribution and infestation can be very heavy. It is a serious pest of unhusked rice and wheat. It also damages sorghum, maize, and millets, and flour, biscuits, paper, etc.

Symptoms. Identifying symptoms are holes in the grain (which may be indistinguishable from those created by other storage insects) (Fig. 56c).

Description and Biology. The beetle is small (about 4 mm long), slender, cylindrical, polished dark brown or black, with a roughened wing surface (Fig. 56a). The head is turned down and covered by a hood-shaped thorax which bears small patches around the edge. Adults lay from 300 to 500 eggs singly or in clusters on grains or in powdery material over a period of 3-6 weeks. In about 5-11 days eggs hatch into fleshy grubs which appear swollen at the extremities. Grubs bore into grains and feed inside (Fig. 56b). The larval period lasts from 25 to 50 days depending on the season. Pupation takes place within the grain or in the grain dust. The pupal period lasts 7-8 days. The total life cycle may take about 2 months and there are 3-4 generations in a year.

Control. Control is similar to that suggested for weevils.

Fig. 57

STORAGE PEST

a

b

c

Rice Moth: *Corcyra cephalonica* (Stainton) (Pyralidae: Lepidoptera)

Distribution. The rice moth is an important pest of stored sorghum, rice, flour, dried vegetable materials, dried fruits, chocolates, biscuits, and oil cakes.

Symptoms. Infested produce is densely webbed.

Description and Biology. The adult moth is a pale grayish brown, with a wing expanse of 14-24 mm, and the head bears a projecting tuft of scales (Fig. 57a). The eggs are spherical and white, and up to 200 are laid loose in the food material. The incubation period is 3-5 days. Larvae are creamy white (Fig. 57c) and web together particles of food and frass with silken threads into galleries in which they live and feed. The larval period is 20-30 days and the pupal (Fig. 57b) period is 9-10 days. The adult moths are short-lived.

Control. Stored commodities should be well dried and proper storage sanitation measures should be taken. Common fumigants are useful.

Fig. 58

STORAGE PEST

a

b

Angoumois Grain Moth:

Sitotroga cerealella (Olivier)
(Gelechiidae: Lepidoptera)

Distribution. The insect is cosmopolitan in distribution and it is one of the important primary pests of stored sorghum and rice grain, but is also known to attack maize, wheat, and barley.

Symptoms. Infestation can begin in the field. In storage, the infestation is confined to the upper layer of the grain. The larvae bore into the grain and remain there until they emerge as adults from round emergence holes. The infested grain is completely hollowed out and filled with larval excreta or webbing (Fig. 58b).

Description and Biology. The female can lay up to 400 eggs that are deposited rather indiscriminately on or between the grains, on the panicle in the field, or on the threshing floor or in storage. The egg is white and oval, but soon turns bright red and hatches within a week. The tiny larva crawls about searching for a comparatively weak spot through which it enters the grain and feeds on the internal contents. The larval period is 2-3 weeks. The moth (Fig. 58a) emerges within a week.

Control. There are a few natural enemies of this pest but they are not of any practical utility. From the control viewpoint the weakest aspect in the life cycle of this pest is the requirement of high moisture-content in the grain. Hence its damage can be kept to a minimum by maintaining grain moisture below 12%. Fumigation is effective.

Fig. 59

STORAGE PEST

Indian Meal Moth: *Plodia interpunctella* (Hubner) (Pyralidae: Lepidoptera)

Distribution. This moth species is a cosmopolitan pest.

Symptoms. The larvae feed upon grains, grain products, dried fruits, nuts, etc., and leave a thick web across the surface of infested food.

Description and Biology. The adult has a wing expanse of about 18 mm (Fig. 59). It can easily be distinguished from other grain pests by peculiar fore-wing markings. These are reddish-brown with a coppery lustre on the outer two-thrids, but whitish gray on the inner or body end. As many as 500 eggs may be laid by one female and the development from egg to adult takes about 26 days. The life cycle of this moth may be prolonged by a diapause under certain temperature conditions.

Control. Fumigation is the recommended control measure. However, during diapause the metabolic activity is very low and normal application rates of control may not prove effective.

Notes

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