Army Worm Moth, twice natural size.

Insect Pests of Field Crops

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Insect pests have done more damage in Missouri during the last three years than in any equal period in the history of the state. Last year the Hessian fly, in a dozen counties of Missouri, cost the farmers more than did all hog cholera outbreaks throughout the entire state.

In Missouri the two most important field crops, corn and wheat, suffer most, tho other crops come in for their share of damage. In this report only the most important insect pests of the different crops will be discussed. Where necessary the records of other workers will be made use of, tho as far as possible original records will be given.

**INSECT PESTS OF CORN**

Corn pests usually feed on grasses but very seldom on legumes. An effort should therefore be made to rotate crops so that the same or similar crops will not follow each other. If a rotation of this kind cannot be practiced land should be fall or winter plowed.

In the control of insect pests of field crops it is seldom advisable to use spray mixtures. Most of the pests can be more effectively and economically controlled by following proper farm practices. Where it is necessary, spray solutions and other artificial remedies should be used as cures, but prevention is always better than cure. Crop rotation, clean culture, fall and winter plowing, timeing of sowing and cutting of crops are all of value in the campaign against insect pests and cost nothing to apply.

**Corn Root Louse, (Aphis maidi-radicis Forbes).** The corn root louse is largely a pest of corn in bottom land where the soil is loose and sandy, tho it may be destructive in prairie sections of the state.

*Description.* The pest is one of the sap-sucking plant lice which lives largely underground on roots of corn and related plants. It is greyish-green in color and about the size of a pin head. By pulling up infested plants hundreds will be found attached to the roots.

*Life History.* The corn root louse winters in the egg stage in the nests of the small corn field ant. The ants collect the eggs in the fall and store them with their own eggs in their nests underground. In the spring when the eggs hatch the ants carry the young lice to roots of grasses and weeds where they feed and increase until the corn crop comes on. The ants then transfer them to the roots of corn. During
the summer there are no males, neither are there true females, but an asexual form, stem-mother, gives birth to the living young. The ants continue to herd the lice all summer and in return feed on a sweet discharge from tubes on the backs of the lice. The underground forms are without wings, but from time to time winged forms emerge and fly to other fields and spread the infestation. In the fall true males and females appear and eggs are laid which pass the winter.

_Injury._ The injury is first noticed before the corn is knee high. The lice suck the sap from the roots of the corn causing it to turn yellow and stop growing where the attack is severe. In less severe cases a partial crop matures tho the root system is always more or less destroyed.

_Remedies._ This pest may breed on the roots of grasses and weeds so crop rotation will give only partial relief. Winter plowing of infested cornfields or sod will destroy the ant nests and along with them their eggs and those of the lice. This is the most effective remedy. Fertilizers may help to mature a crop in spite of the pest and close and continuous cultivations when the corn is small will help to aggravate the ant and check the pest. Get rid of the ant and the louse is helpless.

_Corn Root Worms, (Diabrotica longicornis Say and D. duodecimpunctata Oliv). _ There are two forms of root worms, the so-called western and the southern form. They are the grubs of small beetles and as the name implies they feed in the roots and base of the corn plant.

_Description._ The root worms are small, whitish grubs. They are very slender and from one-half to nearly three-fourths of an inch long. When feeding they will be found partly or entirely buried in the roots or base of the young corn plant. The parent beetle of the southern form is yellowish-green with twelve black spots and looks much like a lady beetle. The parent of the western form is smaller than the southern form and light green in color.

_Life History._ The parent of the western form lays its eggs largely in cornfields in the fall. In the spring these eggs hatch and the grubs attack the corn. There is but one generation a year. The southern form attacks various plants and the beetles hibernate in protected places and appear early in the summer to lay eggs.

_Injury._ The injury to corn is done entirely by the grubs underground. This injury may completely destroy the crop. The injury to the root system saps the vitality of the crop and later causes it to fall badly. During the summer the parent beetles may attack the blossoms
Fig. 1. Corn Root-louse, wingless viviparous female or stem-mother; about sixteen times natural size; a, tip of abdomen still more enlarged. (After Forbes.)

Fig. 2. Corn Root-louse, winged migratory stem-mother; sixteen times natural size. (After Forbes.)

Fig. 3. Corn-field Ant, the worker ant which is the true shepherd of the root-louse; eight times natural size. (After Forbes.)

Fig. 4. Western Corn Root-worm; grub in tip of corn root showing the way it feeds; about three times natural size. (After Forbes.)

Fig. 5. Western Corn Root-worm; adult beetle; ten times natural size. (After Forbes.)
Fig. 9. Corn wireworm: four times natural size. (After Forbes.)

Fig. 6. Southern Corn Root-worm; back view of grub; about six times natural size. (After Forbes.)

Fig. 10. Corn wireworm: parent "click-beetle" four times natural size. (After Forbes.)

Fig. 8. Common wireworm. Young wireworms feeding on roots of grasses; and adult and larva about three times natural size. (After Brehm.)

Fig. 7. Southern Corn Root-worm; adult beetle; about six times natural size. (After Forbes.)
of various plants causing considerable injury in case of melons and similar plants.

**Remedies.** The western form is controlled by crop rotation. Most of the eggs are laid in the fall in infested cornfields. If corn is not planted in the same field the next year the pest is starved out. The southern form is less easily controlled. Crop rotation combined with winter destruction of harboring places and late planting of corn will usually control the pest.

**Wire Worms, (Elateridae).** There are a great many kinds of wire worms but their habits are similar and may be considered as a single pest.

**Description.** The wire worms are the grubs of small oblong brownish beetles known as click-beetles or “snapping-bugs.” The grubs are brownish in color and as the name implies are hard and wiry. They vary in size, but are usually an inch or less in length and as large around as a small straw. They have legs but crawl with difficulty.

**Life History.** This pest may require from one to three years to mature. The eggs are deposited largely in sod and the grubs feed on the roots of grasses until mature, unless the sod be plowed under and some other crop such as corn, wheat or similar crop follows to be injured by the grubs. The parent beetles do not injure field crops.

**Injury.** The injury to corn is usually done just as the corn is sprouting or soon thereafter. The grub may bore into the soft sprouting grain destroying the germs or it may eat off the roots or bore into the base of the stalk after the plant has started. The injury to wheat and other crops is of a similar nature.

**Remedies.** The wire worms are rather difficult to control tho by following out a careful system of crop rotation combined with fall or winter plowing the pest can be kept in check. A field should not be kept in sod too long and such crops as wheat and corn should not follow sod if it is known to be infested. The pest does not seem to thrive in fields where legumes are grown, so it is usually safe to follow clover with corn or wheat. Treating the seed corn to protect it from the pest is at best only partially effective.

**White Grubs or Grub Worms, (Lachnosterna spp.).** These are the young of the brown May beetles or so-called “June Bugs” and, like the wire worms, usually breed in sod where they may become so abundant as to destroy much of it. When the sod is plowed under in the spring and is followed by corn, that crop also suffers.

**Description.** This pest is best known in the grub or larval stage and is commonly called the grub worm. There are many species, but
Fig. 11. Whitegrub: a, adult June beetle; b, egg; c, whitegrub or grub worm; d, pupa; e, corn plants with roots injured and grub and pupa in earthen cells.
all have similar habits. When found they are usually curled up, whitish or yellowish in color with a brown or black head and with dark food usually showing thru the body. The parent beetles are brown or blackish and are common in May and June coming into lighted rooms at night, buzzing about until they strike something and fall heavily to the floor.

Life History. This pest may also require from one to three years to mature depending upon the species. The eggs are laid in the soil, usually in pastures and meadows. On hatching these eggs produce the grubs which feed until mature. They pupate in May and June and come out as beetles to lay eggs for the next generation.

Injury. The grubs feed underground on the roots of grasses and various other crops often completely eating away the root system. We have found the injury to be so great that in many cases the sod could be stripped from the ground and rolled up like a carpet where the grubs have eaten off the root system. When such infested fields are plowed and corn is planted they completely destroy the corn crop.

Remedies. The remedies suggested for the wire worms are also helpful in controlling the grubs. Hogs are fond of the grubs and are often of help in cleaning up the infested fields.

Sod Webworms, (Crambus). There are several species of sod webworms. They are small caterpillars which breed abundantly in sod. When the sod is plowed in the spring and corn is planted they turn to the corn.

Description. The sod webworms are about an inch long when full grown and usually reddish-brown in color. The body has numerous rather conspicuous tubercles from which project short bristling hair. The worm is very active. The moths vary in color but are easily distinguished from others by the habit they have of folding the wings down along the sides of the body so as to resemble a portion of bleached grass blades more than a moth. The moths are the common light colored ones which fly up ahead of one while walking in pastures.

Life History. There seem to be but two broods a year. The winter is passed by the partially grown caterpillars in the ground and these are the ones which destroy the young corn. They mature by June and the moths usually fly to sod to lay eggs for the summer brood which matures and lays eggs for the brood which again passes the next winter.

Injury. The injury to grasses in pastures and meadows is great but usually entirely overlooked. It is the injury to corn which attracts attention. Corn planted on sod land spring-plowed often suffers severely. In some cases three or four plantings are necessary before a
stand is obtained. The worms injure the corn by feeding on the roots, cutting plants off like cutworms, by eating gashes in the sides of the stalk near the ground or they may work down in the growing tip. The injury usually results in the loss of the plant.

Remedies. Late summer or fall plowing is the only practical method of reaching the pest. This deprives the fall brood of young worms of food and usually cleans up a field so that there are few to pass the winter and attack the corn crop. When the pest shows up and injures the first planting, replant a couple of weeks later or until a stand is secured.

Fig. 12. Sod Webworm: a, adult moth; b, fullfed caterpillar; c, pupa; d, injured corn plant, showing caterpillar in under ground tube. (Original.)
Corn Bill-beetles, \textit{(Sphenophorus ochreus and parvulus)}. These beetles have their mouth parts at the tip of a drawn-out snout, as the name implies, and by means of the snout, the beetle is able to eat holes into the young corn plants thereby injuring or completely destroying the plants.

\textit{Description}. There are two very common species of these beetles in the state, besides other less common ones. The one is grayish in color and from one-half to three-fourths of an inch long, while the second is black and less than one-half the size of the other. They are oblong in shape and the body is very hard. When disturbed they feign death and drop from the plant.

\textit{Life History}. The pest breeds largely in low pastures where wild grasses and sedges abound. The grub stage of the pest feeds in the bulbs of such plants and when mature comes out and feeds on grasses and other crops. There is but one brood a year and the beetles appear about the time corn comes up.
Injury. The injury to corn, wheat and similar crops is due to the feeding of the mature beetle. The mouth parts are at the tip of the bill and by eating holes into the developing stalk of corn the growing bud may be destroyed. Later, as the leaves expand, where the plant is not completely destroyed the effects of the work of the beetles appear as rows of holes in the leaves.

Remedies. The injury from this pest is most effectually prevented by plowing infested fields in the summer or fall, thereby killing or driving out most of the beetles before the corn is planted the next spring. When they appear in a cornfield there is no way of destroying them except by hand picking.

Chinch Bug, (Blissus leucopterus Say). This pest is perhaps most destructive to the wheat crop, tho corn is seriously injured and the injury to grasses is also very considerable. The pest appears as a scourge more or less periodically. For a series of years there are few chinch bugs and no damage is done, but all of a sudden a visitation of the pest occurs and then for four or five years they are abundant and destructive.

Description. The chinch bug is so well known that a description of it is hardly necessary. The very young bugs are red but as they pass thru the different stages of development they turn dark. The mature winged bugs are black with whitish spots on the wings. They are about the length of a wheat grain. When crushed they give off the characteristic, penetrating bug odor.

Life History. In this state there are two generations each year. The pest winters in the mature winged stage in dead grass, under rubbish, and in other similar protected places. Early in the spring, the bugs fly in search of wheat and other crops, where their eggs are deposited. These hatch and the young bugs are nearly mature at wheat-cutting time, when they migrate to corn and other green crops. This generation is soon mature and the second crop of eggs is laid. These hatch and the second generation of bugs feed on the sap of corn and other green plants maturing before frost when they fly in search of winter quarters.

Injury. This pest injures the plant largely by piercing and extracting its sap, tho along with this it seems to inject a certain amount of poison somewhat similar to other sucking insects, as for example the mosquito. Early in the season the injury to wheat, due to the work of the millions of tiny bugs, begins to appear as a stunting of its growth. Later the wheat turns yellow and may be completely killed, tho more often it heads out and matures a small quantity of inferior grain. Where grass and clover seed is sown in wheat fields,
Fig. 15. Chinch-bug: a, egg; b, c, d, e, four nymphal stages; f, mature chinch-bug; g, wheat plant showing a number of eggs natural size. (Original.)
the pest first destroys the wheat and then turns to the grass, leaving the clover alone.

After the summer migration the corn suffers most. The bugs may kill the first few rows of corn during the migration. After they get wings they fly all over the field and may seem to do no further injury, tho in fact they multiply one hundred fold and while their work is scattered, it is greatly increased and the damage is far greater than the farmer supposes. Legumes of all sorts are left strictly alone.

**Remedies.** There are various means of attacking this pest and each farmer should make use of the method which best suits his particular conditions. The most effective work can be done during the winter and just at the time the summer migration occurs. Between fall and early spring the winter-over bugs are all harboring in protected places. If these places are burned over or treated so as to kill or expose the bugs, the number of bugs can be so reduced that few will come out in the spring to start the trouble.

In the summer, if the pest is prevented from migrating from wheat fields to corn or other crops by means of barriers, it can be starved out. The dust barriers are most practical during the dry weather but in case of rain a chemical barrier is necessary. The simplest dust barrier is made by plowing one or more parallel ditches and dragging a log or trough back and forth in the ditches so as to keep a fine mulch of dust in them and grind up the hords of bugs as they fall into them. A plowed strip, which is carefully pulverized and kept stirred by means of a harrow or weighted brush is also effective. The bugs migrate from about eight o'clock in the morning until sundown so the dust must be kept stirred during this time. The migration period seldom lasts more than two weeks.

When it is not possible to maintain a dust barrier, some chemical repellant must be used. Several materials have been tested and of these coal-tar, heavy road oil, crude carbolic acid and creosote have proven most effective. Some one of these materials should be on hand or the grower should know where he can get them without delay. Before applying, first smooth down a narrow path with a hoe or shovel. Then run a narrow line of the material. By driving a nail thru the side of a powder can or other cheap pail the material can be easily and quickly distributed without waste. The line must be renewed to keep it fresh so that the bugs will not cross. Postholes dug every ten feet to trap the bugs, as they crawl along the barrier in search of a place to cross, are also helpful.

Besides these two methods of attack the use of oil sprays where the bugs get over before the barriers are formed, and a dozen other
simple treatments can be used to reduce their number. Keep corn-fields as far from wheat fields as possible so as to prevent the summer migration.

The fungus disease which attacks the pest and which was much exploited in former years has so far not been able to develop and help control the present visitation of the pests. The last three summers have been so dry that the spores of this fungus have not been able to develop. The fungus spores are distributed in all fields and will sprout and develop when the weather conditions are entirely favorable, but not until then. Farmers must, therefore, depend on their own efforts to check the pest and when weather conditions, over which they have no control, are right the disease will spring up and help destroy the pest.

The past winter has been rather severe but there was an unusually large supply of bugs which went into winter quarters and, where they were not destroyed by burning over their harboring places, they have come out in countless swarms and unusual injury may be expected this summer.

Corn Ear-worm, (*Heliothis obsoleta* Fab.). For the last few years this pest has probably destroyed more corn in Missouri than any other single insect pest. It is a very general feeder and is not confined to corn tho that crop suffers most.

*Description.* Everyone is familiar with this caterpillar. Like the army worm, which it somewhat resembles, it varies in color but is usually greenish or blackish with light stripes. The worm commonly found in ears of corn, in green tomatoes, bean pods, etc., is the corn ear-worm. It is closely related to the cutworms but is seldom found feeding exposed. The parent moth is brownish, variegated with black, expands about an inch and a half and may be seen about flowers in the daytime, which is unusual of moths.

*Life History.* The pest winters underground as a brown pupa and in the spring the moth emerges. In Missouri there seem to be two generations before corn "shoots" and seemingly a number of summer and fall broods. This has not been carefully worked out but caterpillars in all stages are to be found until frost. The resting or pupal period of a few days is always passed in the ground where the full-fed caterpillar goes when it leaves the corn.

*Injury.* The injury to corn is due to the fact that much corn is eaten and an entrance is provided for smuts and other plant diseases, some of which seem to be responsible for part of the stock poisoning where smutty corn is fed. The pest is always more troublesome when the summer is dry and is followed by a rainy fall. The last three years
have been especially favorable for the pest and the injury has been unusually severe.

The corn ear-worm is primarily a pest of field and sweet corn, but it may also do much damage to other crops, such as tomatoes, cotton, beans, cowpeas and may do considerable injury to young alfalfa in the fall. It feeds largely as a borer within the plant where it is difficult or impossible to reach it with poison.

Fig. 16. Corn Ear-worm: a, moth; b, egg enlarged; c, larva; d, pupa in earthen cell; e, larva feeding on corn ear. (Original.)

Remedy. Since the pest winters as a pupa underground, winter plowing of infested fields will expose the pupae to the winter and few will live to give off moths in the spring. If it were possible to winter plow all fields where the pest is wintering this alone would prove effective, but the pest is such a general feeder that it is not possible to reach all of them in this way.
The parent moth lays its eggs largely on the corn silks. After hatching from the eggs the caterpillars must enter the corn-ear and it may be possible to devise some practical method of destroying the eggs or caterpillars before they enter the ears.

This is being investigated at the Agricultural Experiment Station, but as yet no treatment has been found which is both practical and effective.

**Army Worm, (Leucania unipuncta Haworth).** The army worm is discussed with the grass insect pests.

**Cutworms, (Noctuidae).** The cutworms are discussed with the grass insect pests.

## INSECT PESTS OF WHEAT

The greater part of the insect injury to wheat is due to the work of a half dozen insects, tho there are a great many of lesser importance. The insect injuries to wheat have been unusually great in recent years and in view of present demands and prices it is important that these pests be controlled.

**Hessian Fly, (Cecidomyia destructor Say).** This is perhaps the most destructive wheat pest in Missouri. The last wheat crop was injured to the extent of about six million bushels. Fortunately this pest confines its injury entirely to the wheat crop.

**Description.** The Hessian fly gets its name from the fact that it is supposed to have been brought into this country from Europe in straw by the Hessian soldiers. Farmers speak of it as the "fly" but very few of them have ever seen the pest in the mature fly stage. It is better known in the soft maggot stage or in the brown flaxseed stage. These can be readily found in the base of injured plants. The fly itself resembles a small black mosquito somewhat and is not easily seen or caught in the field. The large long-legged crane-flies are often mistaken for the Hessian fly.

**Life History.** The development of the pest is greatly influenced both by temperature and moisture. Normally there are three broods a year in Missouri, one fall and two spring broods. Some years, however, there may be only two broods and other years there may be four broods.

Beginning with the fall brood, the flies begin to appear by the middle of August and but few continue to appear after the middle of October in a normal fall. Each fly lives but a few days and each female lays one hundred or more eggs. On hatching the maggot works
down between the leaf and the stem of the young plant where it injures the plant and feeds on the escaping sap. When full-grown the maggot passes to the flax-seed stage which is merely the full-fed maggot pro-
tected by the maggot skin which turns brown. Early in the spring the maggot transforms to the resting stage within the brown case and later the winged fly escapes to lay eggs for the first spring brood of maggots. These mature and pass thru the flax-seed stage and emerge as the mature flies in time to lay eggs for the second brood of maggots. This second brood of maggots matures and passes the summer largely in the stubble in the flax-seed stage and the adult flies from these are the ones which come out in the fall to lay the eggs for the fall brood of maggots.

When the spring is dry or unusually cool the second brood does not appear and the flax-seed stages of the first spring brood pass the summer in the stubble. In like manner when the fall is unusually rainy and warm, as in 1914, an additional partial fall brood may appear about the first of November.

Injury. The injury is done entirely by the maggot feeding in the base of the wheat plant. The hard, brown flax-seed stage, often called the "egg," does not feed, neither does the winged fly. The fall injury may be so severe that the entire field turns yellow and dies tho more often "tillers” are formed to replace the injured central plant. The maggot does not eat the plant off but merely rasps on the tender stem causing the sap to flow, which it uses for food.

The spring injury, similar to the fall injury, causes the wheat to dwindle and turn yellow. The maggots feed higher up on the plant but are largely confined to the first few joints. The lodging of wheat is due to the fact that the maggot feeds at the joints and causes the stem to become brittle and deformed so that heavy winds cause it to bend or break after it heads.

Remedies. There are two practical methods of reaching this pest. After the wheat is cut the flax-seed stages are found in the stubble. If this stubble can be entirely destroyed, by plowing under thoroly or, if necessary, by burning, few will survive to give off the flies in the fall. Then in the fall if it is possible to delay wheat sowing until all or nearly all the flies have come and gone the young wheat will come up and not be infested. The eggs are laid on the leaves of the wheat and if the seed wheat is still in the granary when the flies are out on wing in search of young wheat the wheat crop will be protected from the pest. For north Missouri wheat should not be sown before the first of October, for Central Missouri the tenth of October and for Southern Missouri the fifteenth to the twentieth of October.

Where wheat is sown according to these directions, there will be some infested wheat especially if the season is a little late and the flies continue to emerge late, but the main injury will be avoided. By
combining the work of destruction of stubble as soon as the wheat is off the field with the late sowing of wheat the pest can be effectively kept under control in any community, if all will cooperate in the work. Cooperation is essential and wheat should never be sown early for pasture in a community where the fly is bad and a campaign is being waged for its control. Volunteer wheat is just as bad as early sown wheat so keep it down and never sow a strip as a trap crop. It is unnecessary and dangerous, to say the least, when for one reason or other it cannot or is not plowed under before the main crop is sown.

**Wheat Straw-worm, (Isosoma grande Riley).** The straw-worm is quite similar to the “joint-worm” which does similar injury to wheat in the states east of Missouri.

*Description.* The parent of the straw-worm is a small dark wasp-like insect with four wings, except in case of some of the spring brood which have only rudiments of wings.

The farmer is not familiar with the adult but has probably seen the gnarled or otherwise deformed places on wheat straws which are brittle and often break into pieces in the thresher and come out with the wheat. This injury is done by the grub stage of the pest. By opening these bits of deformed wheat straw the small white grubs will be found inside.

*Life History.* The straw-worm has two broods a year. The winter is passed in the straw and early in the spring the adults emerge and deposit their eggs in the wheat near the crown, where the grubs feed. The grubs mature and the adults appear and lay eggs for the second brood which again winters in the straw.

*Injury.* The injury is something similar to that caused by the spring broods of the Hessian fly. The pest saps and kills the plant or weakens the straw, causing lodging. Joint-worm injury is often mistaken for fly work.

*Remedies.* The joint-worms are not difficult to control as a rule. By using up the infested straw before spring and rotating the wheat to other fields this pest can be easily controlled since most of the adults of the first spring brood are without wings.

**Grain Lice, (Macrosiphum granaria Bucton and Toxoptera graminum Rond.).** There are two forms of green lice which have been known to do damage to wheat in Missouri. The common form is present every year but only occasionally does damage. The other form is known as the spring grain louse or “green-bug” and has visited Missouri but once in recent years and then in very destructive numbers.
FIG. 18. Wheat Straw Worm: a, larva ventral view; b, larva sideview; f, adult female; g, and h, front and hind wings of winged form; i, rudimentary wing of wingless brood all enlarged. (After Forbes.)

FIG. 19. Wheat Straw Worm showing injured straw with opening thru which the adults have emerged. a, adult. (Original.)

FIG. 20. Grain Plant-louse on wheat head natural size. (From Forbes.)

FIG. 21. Grain Plant-louse, on head of wheat enlarged. (After Weed.)
Description. These lice resemble the other green plant lice and will be found either on the wheat heads or on the leaves sucking the sap from the plants.

Life History. The common form may winter on wheat in Missouri but the second form seems to winter in the southern states and migrates north in the spring. During the summer they reproduce rapidly and when not checked by natural enemies often overrun the wheat and related crops.

Injury. The common form when destructive at all will be found covering the wheat heads when the grain is "in the milk." A few days of heavy feeding at that time will decrease the yield. The spring grain louse is destructive earlier in the spring when the wheat is yet small. When it gets an early start in the southern states and the northern spring is backward, the grain louse, which breeds freely in cool weather, migrates north and being unchecked by lady beetles and other natural enemies it is able to destroy much wheat.

Remedies. There is seldom any need of applying remedies for these pests. Only under exceptional conditions do their natural enemies, lady beetles, parasitic wasps, syrphid flies and aphid lions, fail to control them.

Wheat Midge, (Diplosis tritici Kby.). This is a close relative of the Hessian fly, but, unlike it, develops in the heads of the wheat, feeding on the soft developing grain.

Description. The injury is done by the small yellow or orange maggot, which is often called the "red-weevil," when it is carried to the stack and comes out of the thresher with the grain. It is about the size of the maggot of the Hessian fly and the adult fly resembles the Hessian fly in general appearance.

Life History. There is seemingly but one brood a year. The pest winters in the ground in the pupa stage and the flies emerge to lay eggs in early summer. Before the grains become hard the maggots are full fed and most of them are washed to the ground by the rain. They enter the ground and prepare a cell in which to pass the winter.

Injury. This pest has not as yet attracted special attention in Missouri, tho it has already crossed the Mississippi River. The injury is done directly to the soft, developing grains. The maggot rasps on these and feeds on the escaping milky juice. This reduces both the quality and quantity of grain. In the last fifty years the pest has not been as destructive in this country as formerly.

Remedies. This pest is readily controlled by crop rotation and by deeply plowing infested fields in the fall and winter.
Fall Army Worm, (Laphygma frugiperda S. and A.). The pest is somewhat similar to the army worm proper, tho its habits are different and it appears as a pest at a different season of the year.

Description. The parent insect is a dark night-flying moth similar to the parent of cutworms but the farmer is more familiar with the caterpillar. The caterpillar somewhat resembles the genuine army worm and the corn ear-worm in general markings, tho a careful examination will reveal differences. It is not quite as large as the army worm.
Life History. The pest winters just below the surface of the ground as the pupa and the moths emerge in the spring. There are two summer broods in Missouri, which do slight injury, and the fall brood, which is often very destructive. The caterpillars of the fall brood enter the ground and pupate in the late fall.

Injury. The year 1911 was the real fall army worm year in Missouri. From a careful study of the work and distribution of the pest that year, it was found to be quite generally distributed over the state and damaged wheat, rye, clover, and alfalfa most. It completely stripped thousands of acres of early sown wheat and rye that year and truly assumed the rôle of an important pest. The heaviest feeding was done before the middle of October, tho some were at work until frost. Like the arm worm they literally devoured everything green, eating wheat down to the ground, killing most of it outright.

Remedies. By discing infested fields late in the fall or early in the spring many of the pupae can be destroyed. When the caterpillars are feeding us the bran mash recommended for the cutworms and army worm. A weighted brush or roller will also help some.

Wheat-head Army Worm, (Meliana albilinea Hbn.). This pest has not done much damage in Missouri in recent years tho it has been destructive in Iowa.

Description. The parent moth is about the size of the moth of the real army worm but is of a pale yellow or straw-color. It flies only at night. The caterpillar varies in color, as is the case with other related caterpillars, but in general appearance it resembles the cutworms and army worm. Its peculiar habit of attacking timothy and wheat heads at once distinguishes it from them however.

Life History. The moths appear and lay eggs early in May. The caterpillar feeds on the blades until the grains are "in the milk," when they attack the wheat heads and first attract attention. When these are full-grown they enter the ground to pupate and the moths begin to emerge the middle of July. These lay eggs for the second brood of caterpillars which feed on grasses and other green crops in the fall. These pupate in the soil and pass the winter there. There are two generations a year.

Injury. The pest was formerly known only as a pest of wheat but in recent years has proven to be a severe pest of timothy in Iowa. It attacks the blades of wheat and grasses when small and later, when half-grown, attacks the heads.

Remedies. Fall plowing in September to destroy the fall brood of worms or winter plowing to destroy the pupa seems to be effective where this pest causes trouble.

Army Worm. Discussed with insect pests of grasses.
Fortunately, the legumes are comparatively free from destructive insect pests. There are a few forms, however, which need attention.

**Clover Leaf-weevil, (Phytonomus punctatus Fabr.).** This is most troublesome on red clover and alfalfa early in the spring. Its close relative the *alfalfa weevil*, which has recently been introduced in Utah, is a most destructive pest of alfalfa and we may some day have it to deal with in Missouri.

*Description.* The adult weevil is about the size of a large pea, slightly oblong, brownish in color and like most weevils or snout beetles, feigns death when disturbed. The grub, which does most of the injury, is about one-half inch long when mature, green or yellowish-green with a white line down its back. It has no true legs, tho it climbs readily, and when disturbed coils up.

**Life History.** It winters largely in the young grub stage, tho occasionally as the adult. The grubs begin to feed early in the spring. They eat round holes thru the leaves and when mature spin frail lace-like cocoons at the base of the plant in which they pupate. The beetles emerge later and in the fall deposit eggs which produce the winter-over grubs.
Injury. Where the pest is abundant it may completely strip clover and alfalfa early in the spring seriously injuring the crop. It is seldom of importance on young clover and alfalfa. As the season advances the injury is less noticed.

Remedies. Remedies are seldom necessary for this pest. By following a careful system of crop rotation, which prevents the keeping of clover on the same land too long, the pest can be kept under control. The pest is also susceptible to a fungus disease which greatly reduces the number of grubs when warm weather arrives.

Webworm, (Loxostege similalis Gn.). This was formerly called the garden webworm but in recent years the term "alfalfa webworm" would describe it much better.

Description. The caterpillar is about an inch long when full-grown, slender, very active and yellowish green in color with rows of small black spots or tubercles. It spins considerable silk, tying the leaves and stems together in which protected place it feeds. The moth
expands a little more than half an inch, is light brown variegated with darker and lighter spots and patches.

**Life History.** The life cycle of the pest has not been completely worked out. It probably passes the winter in the caterpillar or pupa stage and the moths emerge in the early spring to lay eggs for the first brood of caterpillars. In 1914 these began to appear, feeding on weeds, about the last of June in central Missouri and were nearly full-grown by the fifteenth of July. During the summer and fall the pest requires about four weeks to mature so that there are probably four generations each year.

**Injury.** The injury is done by the caterpillar, which when abundant completely webs up and devours all the foliage on alfalfa, clover, and other field and garden crops. The pest was unusually destructive to young alfalfa during the summer and fall of 1914.

**Remedies.** Winter plowing and burning of weeds and other rubbish in infested fields will help control the pest. When the pest appears in an alfalfa field the crop should be cut at once so as to starve out the caterpillars. The use of a weighted brush, roller or disc on infested fields will also help to destroy the pest. The pest is likely to reappear again a second year where conditions are favorable, but if the first broods are controlled the later injury will be avoided.

**Clover-hay Worm, (Hypsopygia costalis Fab.).** This is largely a pest of clover hay in the stack and to a less degree in the mow, tho it has done some injury to growing clover in Missouri where the crop was unusually heavy on the ground.

**Description.** The pest is a small, active, reddish-brown caterpillar which when full-grown is nearly an inch long. It is usually found associated with silk which it spins in the clover hay. The small moth expands nearly an inch and its wings are tinged with purple and marked with golden blotches.

**Life History.** The fulled caterpillars pass the winter, pupate, and the moths begin to emerge in June. In two months the moths of the second brood begin to emerge and the caterpillars which hatch from their eggs are fulled before winter.

**Injury.** This pest does not actually eat a great deal of the clover hay but it webs up the hay so that stock will not feed on it. Clover hay is most severely attacked where it is carried over a second year.

**Remedies.** The pest can be prevented from injuring hay if all the hay is fed out in the spring before the new hay is brought in. When the clover hay is stacked in the field, it should be kept off the ground so that it will remain dry. It has also been found that half a gallon of salt to a ton of clover hay will help to keep the pest out of it.
Clover Seed Pests. There are three insects which attack the clover seed. One is a gnat, the clover seed midge; one a wasp, the clover seed calcid; and one a caterpillar, the clover seed caterpillar. Where clover seed is grown extensively these pests may prove to be of very great importance by reducing the yield.

In each case the young active feeding stage, maggot, grub and caterpillar, devours the seed or eats out the interior. The pests are exceedingly small and few growers are likely to see them, tho their effects are noted when the seed is threshed.

Remedies. Where one or more of these pests are abundant and destructive, cut the first, the hay crop, a little early. This destroys the infested blossoms before the young pests are fulfilled and it brings out the blossoms of the seed crop earlier so as to escape the next brood of the pest.

Corn Ear-worm. This has been discussed with the insect pests of corn. It is also a pest of legumes boring into the pods of cow-peas and other legumes, and at times it may feed on alfalfa.
**Fall Army Worm.** For a full discussion of this pest see insect pests of wheat. It often does much damage to young clover, and alfalfa in the fall and may, therefore, be a severe pest of legumes.

**Army Worm.** This pest ordinarily does not do much damage to legumes, but in some parts of the state in 1914 it completely stripped fields of alfalfa and clover. It will be discussed with the insect pests of grasses.

**INSECT PESTS OF GRASSES**

Many of the insects already discussed as pests of other crops may also attack grasses. In some cases they are pests of other crops only when infested sod is plowed under and those crops follow. This is true of white grubs, wireworms, cutworms, "bill-bugs," etc. The pests to be discussed here may also do much damage to other crops.

**Army Worm, (Leucania unipuncta Haworth).** This pest is more or less injurious in some parts of the state every few years, but seldom appears as a general scourge over the state. In 1914 it was unusually abundant and its destructive work was the greatest on record, with the possible exception of the outbreak in the early sixties. Destructive colonies of the caterpillars appeared over practically all of the farming sections of the state.

*Description.* The army worm is more slender than the cutworms and far more active but in general appearance resembles the common cutworms. It varies in color but is marked with light and dark stripes which run lengthwise of the body. When full-grown it is nearly two inches long.

The parent moth expands nearly two inches, is light brown in color with a single white spot in the center of each front wing. It flies at night and feeds on fruit juices and other liquids.

*Life History.* The pest seems to winter in different stages, tho largely perhaps as the moth or young caterpillar. The first brood, which begins to attract attention late in May, is the only one which does damage, tho it is claimed there are two later broods in the summer and fall. The pest breeds very largely in meadows and pastures and, when not too abundant and dry weather does not set in, no migration occurs, but when food is scarce the caterpillars migrate. When the caterpillars are fulfilled they pupate in the ground or under rubbish. The moths appear in perfect swarms by the middle of June and after a few days their numbers decrease, either due to migration or normal mortality. In 1914 no further injury was done by the pest
during the summer, tho just before frost the moths were again quite numerous.

Injury. This pest is not a very general feeder. It depends largely on grass-like crops, truck crops, and occasionally legumes. The injury is done by the innumerable swarms of caterpillars which devour every palatable thing in their reach. Wheat is largely headed and the injury to it is less than to grasses, oats, corn, and other immature crops. The pest breeds largely in meadows, and bluegrass pastures and injury to cultivated crops never occurs until the grass is consumed and the immature caterpillars are forced to migrate. In 1914 the injury to grass and cultivated crops was enormous.

Remedies. In the control of this pest the farmer must be on his guard and ready to act promptly when the time comes. The caterpillars will be found working in meadows and pastures for about two weeks before migration begins. They hide during the day and begin active feeding just before sundown. The young caterpillars can be
effectively and economically controlled by sowing broadcast poison bran mash made by mixing fifty pounds of bran, two pounds of Paris green, one quart of sorghum and enough water to make a paste. Some recommend the addition of three lemons cut fine as a further appetizer. Before migration begins a weighted brush, drag, or roller will help reduce their numbers.

After the migration begins, barriers are most practical. These may consist of a furrow in which a log or trough is kept going, a deep ditch with postholes, greased railroad railings, greased planks on fence, a strip of bran mash, a strip of grass sprayed with poison and other similar treatments. The furrow and log or trough is most practical and economical and during the outbreak of 1914 proved very effective. If the pest gets a start in a cultivated crop throw up one or more barriers in advance of them and also maintain a barrier at the edge of the field where they continue to enter.

While man is doing all he can to check these unnatural outbreaks he should not lose sight of the good work of his numerous friends, consisting of large and small ground beetles and their slender black

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**Fig. 28.** *Bluegrass pasture completely stripped of every blade of grass by the army worm.*
grubs, parasitic wasps and flies, blood-sucking bugs, birds, toads and other insectivorous animals. These, under normal conditions, keep down most of the pests of crops without man’s help, and when man is obliged to lend a hand to save his crop, he should do so promptly and ungrudgingly.

![Ditch barrier used in protecting wheat fields from the migrating army worms.](image)

**Cutworms, (Noctuidae).** There are a great many species of cutworms but as their life habits and work are similar they will be considered as a single pest. They attack various crops but their work is most noticeable where corn follows infested sod plowed in the spring.

*Description.* The injury is done by the caterpillar and most farmers are familiar with the smooth dull-colored cutworms. They vary in size and color markings and when found their bodies are usually tightly stuffed with food and curled up. The parent moths vary even more than the caterpillar in size and general appearance. They fly at night and are usually dull-colored and expand from about an inch to an inch and a half.

*Life History.* The life cycle of the different species varies. They may pass the winter as the caterpillar, pupa, or adult moth. The caterpillars are most abundant and destructive in the spring. These are usually fulled by summer and the moths emerge to lay eggs for the next brood. There is usually only one generation a year in Missouri.
FIG. 30. Variegated Cutworm: a, moth; b, cutworm feeding; c, cutworm in curled position; d, dorsal view of cutworm; e, egg enlarged; f, egg mass on twig. (From Howard, U. S. Dept. of Agriculture.)

FIG. 31. Greasy Cutworm back and side view enlarged. (After Forbes.)

FIG. 32. Greasy Cutworm; adult moth natural size. (After Forbes.)

FIG. 33. Red-legged Grasshopper; natural size. (After Forbes.)
Injury. After the cutworms are half-grown they are voracious feeders. They often cut off all the young corn, making it necessary for the farmer to replant. One caterpillar may cut off many plants and usually eats but a small portion of each plant. They feed at night and hide under clods or in the ground during the day.

Remedies. As a prevention, plan rotation so that hill crops will not follow sod, or if this is not possible, plow sod in the fall. As a direct remedy distribute poison bran mash by mixing fifty pounds of bran and two pounds of Paris green and then add a quart of sorghum and enough water to make a thick paste. This can be sown broadcast or distributed in patches or along a line, so that the cutworms find it. It should be distributed late in the evening or during the night.

Grasshoppers, (Melanophus femur-rubrum and differentialis). The grasshoppers are pests of cultivated crops only when they migrate from meadows or pastures in the summer or fall.

Description. There are two forms which do most damage in Missouri. The one is the small very active red-legged grasshopper, and the other is the larger, heavier so-called "differential grasshopper." The large bird grasshopper seldom does much injury.

Life History. Normally these grasshoppers winter in the egg stage in packets underground, tho some eggs may hatch in the fall and the young hoppers live thru mild winters and be ready to feed in the spring. There is only one generation each year, the young hoppers maturing in the fall to lay eggs for the next year's crop.

Injury. Grasses and grass-like crops are the normal food of these pests and so long as the supply lasts they are not apt to migrate. When necessary they may feed on the foliage of corn, wheat, oats, legumes, truck crops, and fruit trees. On corn they eat off the soft parts of blades weakening the plants and injuring the yield.

Remedies. In Missouri the grasshoppers are not likely ever to become a general scourge tho each year they do considerable damage. If it should ever be necessary, a systematic campaign to destroy the
eggs in the fall by discing and plowing will control the pest. This
together with poison bait early in the summer is the best means of
keeping the pest under control. The best bait known is the “Criddle
mixture” and is made by mixing together a barrel of fresh horse
manure, one pound of salt and one pound of Paris green. This is
then sown broadcast over the infested fields in strips. The bran mash
consisting of fifty pounds of bran, two pounds of Paris green, two
quarts of sorghum and three lemons cut up fine, is a good substitute
for the “Criddle Mixture.”

Grass Leaf-hoppers, (Jassidae). There are a great many species
of these small sap-sucking insects. Some of them may be quite de-
structive to wheat, rye, legumes and other crops as well as to grasses.
They vary in size and color, tho most of them are of the same general
wedge-shape. They are very active and, as the name implies, hop readily. They are not related to the grasshoppers however.

Life History. But little is known of their development and life
cycle, tho many are known to winter in rubbish, which makes it pos-
sible to reach them with winter burning of rubbish, dead grass, and
other materials in which they may be harboring. Pasturing, dragging,
rolling, and discing of infested crops where possible will also help to
aggravate and drive out the pest. Better and more effective remedies
are needed to control these.

INSECT PESTS OF STORED GRAINS AND SEEDS

There are two groups of insects which affect stored products,
moths and beetles. In the first case the caterpillar does the injury
while in the second case both the grub and the parent beetle may
feed. All pests of stored grain are commonly spoken of as grain
“weevils.”

Beetles. In this state we have more or less trouble with the small,
brown “saw-toothed grain-beetle,” (Silvanis surinamensis), the small,
brown snout beetle or “granary weevil,” (Calandria granaria) and the
“Cadelle” (Tenebroides mauritanicus) a large flat beetle whose grub
is milky white and when fulled nearly an inch long. These beetles
may all be found feeding in the same bin.

Besides these there are also the bean and pea weevils (Bruchus).
The bean and cowpea weevils continue to breed and feed in
storage while the garden-pea weevil does not.

Moths. In this state the most important forms attacking grain
are the small grayish “Angoumois grain moth” (Sitotroga cerealella)
and the slightly larger "Indian meal-moth" (*Plodia interpunctella*), tho in mills the "Mediterranean flour-moth" (*Ephestia kuehniella*) and the "meal snout-moth" (*Pyralis farinalis*) may do much damage. The
caterpillar of the first moth bores into the grain while the caterpillar of the second spins some silk and feeds more on the surface, eating out the germ of the seed, especially wheat. The caterpillars of the last two moths ruin much grain and milling products besides clogging pipes with their silk webs.

Remedies. Fumigation is most effective for all these stored grain and seed pests. Carbon bi-sulphide is to be preferred where it can be placed in shallow vessels on the top of the infested grain so that its fumes, which are heavier than air, may pass down thru the grain reaching and destroying the pests. The eggs may not always be destroyed and a second fumigation may be necessary. From one to five pounds of carbon bi-sulphide are necessary for 1000 cubic feet of space, depending upon temperature and freedom of the bins from cracks.

Where the granary or mill can be closed tightly hydrocyanic acid gas may be used. This gas is a deadly poison and must be used with care. In some cases heat can be used in mills and elevators in preference to gas. Insects cannot long survive when they are subjected to a temperature of about 120° F.

INSECT PESTS OF COTTON

Cotton growing is restricted to a few of the southern counties of the state and fortunately cotton there is not severely injured by many insects. The “cotton boll-weevil” has not yet reached that region and probably never will. The common pests such as grubs, cutworms, etc., which attack the crop can be controlled as described for other crops.

Cotton Worm, (Alabama argillacea Hbn.). This pest is more or less destructive every year in the cotton belt of the south and often the moths migrate northward when Missouri’s cotton crop suffers. During the northward migration of the moths they attack ripening fruit doing much damage to it.

Description. The parent is olive brown with a purplish lustre and expands nearly one and one-half inches. Late in the fall these moths are attracted to lights along with the army worm moth. The stripped caterpillar is slender, very active and moves about by looping like a measuring worm.

Life History. In the south the moths pass the winter in protected places and during the summer there are a number of generations. In this state most of their injury is done after August. The fulfed caterpillars pupate in a frail cocoon made by tying together a leaf with a few silk threads.
Injury. The caterpillars seem to feed entirely on cotton and when abundant may completely strip it of its foliage, greatly reducing its yield. They also attack the squares and blossoms.

Remedies. The pest is really controlled by use of arsenicals and when it begins to attack cotton arsenicals should be applied promptly.
Cotton Boll-worm, (*Heliothis obsoleta* Fab.). This caterpillar is the same one which has already been discussed as the "corn ear-worm." It is very destructive to cotton some seasons, and, as in case of corn, the pest is difficult to control. Winter plowing of infested fields, the use of arsenicals when the caterpillars are boring into the bolls and the use of late corn as a trap crop seems to be the most practical methods of reaching the pest and protecting cotton from it.