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Insects Injurious to Stored Grain.

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INSECTS INJURIOUS TO STORED GRAIN.

J. M. STEDMAN.

INTRODUCTION.

In the Southern States more particularly, the stored grain and seeds are usually greatly damaged, if not entirely destroyed in one season, by the attack of insects, principally weevils. The amount of damage needs no comment. It has been stated that grain affected with insects is injurious to stock; but whether this be true or not, it is of little consequence compared with the injury done to grain used for seed. When injured grain is planted, there will be a poor "stand," since the essential part of the seed is usually eaten away and germination rendered impossible; or else if the seed germinates, it has been robbed of much of the nourishment placed there by nature to enable it to attain a healthy and vigorous start, and such seeds will yield a small crop. Instances have come under my observation where whole graineries of corn have been entirely ruined; and it is almost impossible to purchase peas that are not badly effected.

Fortunately we have methods by which we can destroy these pests in our graineries, and there is no excuse now for suffering any considerable loss from insects in stored grain. I find, however, that few understand these methods, and how easily and cheaply they may be applied. There are nine different species of insects that may attack stored grain in Alabama, and in all cases the method of combatting them is the same.

In order that one may determine the kind of insects found in stored grain, I have given a figure of all but one, and a short description.

Figures 12, 13, 14 and 15, were kindly loaned by the Mississippi Experiment Station.

The discussion of the life history of the insect is given only in so far as it is important that the farmer should know it.

In view of the fact that the edition of bulletin number 45 on Injurious and Beneficial Insects has long since been exhausted, and that the demand for it still continues, on account of the general remarks, insecticides and machines for applying the same that it contained, I have here repeated, with some additions and omissions, that portion of Bulletin 45.

GENERAL REMARKS.

In order to arrive at the best results in combatting insects, it is important that we should understand at least the general life history of the insects in question, that we may thus know at what stage in its development means can best be taken to destroy it. Some insects can best be fought in the egg stage, others in the larva or worm stage, a few in the pupa stage, and still others in the adult stage; while many can be controlled in two or more stages. To arrive at this in a scientific way forms one of the great problems of the economic entomologist.

The larger number of our insects have four well defined stages of growth. The first is known as the *egg* state and of course in itself can do no harm. In a few cases these eggs are deposited in clusters or groups and in such a way that we can gather and destroy them, or when this is not practicable, they can be killed by spraying them with kerosene emulsion or soda and caustic soap.

Many insects winter in this egg stage as well as in the pupa or in the adult state, and since they frequent sheltered places, as leaves, rubbish and brush along fences and ditches, etc., it becomes important that all such useless material be gathered and burned every fall, thereby destroying many insects that otherwise would appear the following spring. Hence clean farming is one sure road to success.

The second, or *larva* or worm state is the one in which most insects do their greatest amount of injury, since it is here that most of the growth and feeding takes place. Many insects are injurious only in this larva stage, as our cotton-worm, cabbage-worm, cut-worm, etc., and all other moths and butterflies. Some exceptions to this rule are to be found, as in our grasshoppers and most beetles, that do as much damage in the adult as in the larva stage in many instances. While again, the Rosechafer that does little or no damage in the larva stage, as an adult, does much injury to our vineyards. The larva or worm does not resemble in the least the adult insect in most cases, and hence unless one be familiar with the subject, he can not tell the adult insect by the larva. The caterpillar or worm changes to a butterfly or moth, the maggot to a fly, and the grub to a beetle. It is in this second stage that most insects are to be controlled.

The third, or *pupa* state is usually a quiet, inactive and perfectly harmless stage. Since many insects winter in this condition we can take advantage of it, and resort in the fall to a general cleaning up and burning of all rubbish, leaves, etc., and to the burning over of stubble and to late plowing.

The fourth, or *adult* or imago stage is the perfect insect, such as a butterfly, moth, beetle, fly, etc., and it is in this state only that the eggs are deposited from which a new brood develops. As stated under the second or larva state, most adult insects except grasshoppers and beetles are in themselves harmless to the farm and garden crops; they deposit the eggs, however, on the respective plants on which the larvæ feed, and in view of this we can take means to prevent such a deposit and hence protect the plant. This is especially true and important in those cases where the larva is a borer and hence can not readily be gotten at in that stage. Hence the necessity of covering up the base of peach trees with straw, cotton seed, ash, etc., to keep the adult from getting at the proper place to deposit her eggs, or of spraying apple trees with Paris green or London purple to prevent the codling moth from getting into the apple, or of

covering the trunks of trees with a sticky or poisonous wash to prevent the borer from entering. All preventive applications must be made just before the adult insect appears, and must be kept up at frequent intervals as long as the adult is in a condition to lay eggs.

So far as the farmer is concerned vegetable feeding insects can be divided into three groups. I. Those insects that live, either in the young or adult stages or both, within the tissues of the plant. These are called borers. They feed upon the juices and tissues inside the plant. II. Those that suck the juices of plants, in which case one finds no parts of the plants eaten away, but the leaves shrivel up and dry or turn another color. These are called sucking insects. They pierce the plant with their mouth-parts and simply suck the juices. III. Those that eat the parts of plants, in which case we find places eaten away, or parts eaten or cut off, as we say. These are called biting insects. They feed upon at least the outer parts of plants and in most cases the inner tissues at the same time.

REMEDIES.—From the nature of the case, it is evident that each of the three groups of insects as above described will require a different mode of treatment.

In general (special and exceptional cases will be noted under their respective heads) the best if not the only way to get rid of the borers is either to dig them out or, as has lately been successfully done in the case of the peach tree borer, pour hot water on that part of the tree that is infected. The application of chemicals after the insect is once inside the plant is of little or no use, since the plant would be killed before the insect could be reached. The application of chemicals to prevent their entering has succeeded in some cases. Paris green or London purple mixed with water (see formula under insecticides) and thrown in the form of a spray (apparatus for spraying will be explained later) on to the plant or parts of the plant liable to be infected, has resulted in lessening the attack in a number of cases where the insect or its young eat their way in through the outer tissue,

but where the adult deposits its eggs inside the tissue beneath the outer layer, this method is of little value. The application of certain substances like coal tar, tobacco, etc., is sometimes used as a repellent. Methods and contrivances to keep the insect away will be noted under the special insect.

The sucking insects cannot be destroyed by putting poison like Paris green on the plant, since these insects do not eat the outside of the plant and hence not the poison. They can insert their mouth-parts through the surface of a leaf covered with Paris green, for instance, and not eat it, but suck the pure juice from the part beneath. They must be killed by simple contact with some chemicals, and a substance like Paris green, which is very poisonous to insects if it be eaten, may not affect the insect in the least to have it covered with the poison. Perhaps the most effectual substance with which to kill sucking insects is what is known as Kerosene Emulsion. (See formula under Insecticides.) This must be thrown on the plant in the form of a spray by means of some kind of a force pump. (See spraying apparatus.) Pyrethrum is an active substance in killing by contact nearly all kinds of insects, but unfortunately it is of late years so adulterated that it is almost useless for the farmer. It comes in the form of a powder and can be dusted on the plants by means of a bellows or mixed with water and thrown on in the form of a spray. (See Insecticides.)

The biting insects can be destroyed by poisoning the parts of the plants effected. To accomplish this we can resort to a large number of chemicals, compounds and patent insecticides. Some of the most useful being Paris green, London purple, White Hellebore, etc. A number of the patent insecticides (so called) that are advertised to kill *all kinds* of insect enemies are of no value to the practical farmer.

The mode of applying the different poisons to kill biting insects varies with the kind of plant infested and also with the insect. Some are simply dusted on to the plant as a powder, others sprayed on with a force pump. The methods

of applying each substance will be given under their respective heads. (See Insecticides.)

INSECTICIDES.

The various substances, compounds and mixtures used to destroy or drive away insects can be divided into three groups. First, internal poisons, that kill by being eaten with the natural food of the insect. Second, external remedies, that kill the insect by contact, either by irritating the skin, or by stopping up the breathing pores. Third, repellants, including substances that keep the insects away by offensive odors or by mechanical barriers.

INTERNAL POISONS.

Paris green is the most important insecticide of its class. It kills by virtue of the arsenic that is here in chemical combination with copper. It comes in the form of a fine powder and can be purchased at about thirty cents per pound. It can be used either as a powder to be dusted, or as a liquid to be sprayed on the plants. As a powder it is to be well mixed with from twenty to forty, and even eighty, times its bulk of flour, Plaster of Paris or air slacked lime; and can then be evenly and thoroughly dusted on to all parts of the plant by means of some kind of bellows or other powder dusting machine. (See machines for applying Insecticides.) One pound of Paris green to the acre is usually sufficient provided the dusting be done evenly and thoroughly. Paris green is sometimes used undiluted, or very slightly so (one part of Paris green to three parts of flour) as is the usual case with cotton, when the poison is placed in two heavy sacks made of some strong cloth, as 8 oz. osnaburg, and fastened to each end of a five foot pole. It is the thoroughness with which this poison is applied and not the strength that secures success. As a liquid Paris green is to be mixed with water in the proportion of one pound poison to from 150 to 200 gallons water. Paris green does not dissolve in water, and since it is very heavy and tends to settle

quickly, it is very essential that the liquid be often and thoroughly stirred. It is to be sprayed on the fruit trees and other plants by means of some kind of force-pump and hose with a spraying nozzle. (See machines for applying Insecticides.) One should be exceedingly careful in spraying peach trees not to get the mixture too strong, since the leaves of this plant are very tender and easily "burned" by Paris green or London purple. A mixture of one pound Paris green to 250 gallons of water should be used on peach trees, and that only when the leaves are young. Apple trees should be sprayed just after the flowers have fallen. Small fruits and vegetables are not easily injured, if at all, by Paris green. Since Paris green is frequently adulterated, it is advisable to test it before making any extensive application. One sample of Paris green analyzed by the chemical department here last year was found to contain not a trace of Paris green, nor even of arsenic or any other poison. Some failures in the application of insecticides are due to poor or adulterated material.

Paris green or London purple may be mixed with Kerosene Emulsion in some cases, and thus an insecticide for both biting and sucking insects is made. The great advantage to be gained by this mixing is the time saved in making one application instead of two. For details see under Kerosene Emulsion.

London Purple is about as good as Paris green as an insecticide in many cases, and has this advantage, that it is much cheaper, costing about fifteen cents per pound, and is also a much finer powder and hence remains suspended in water much longer. It is to be used in the same way and in the same proportions as Paris green.

Hellebore (white) is a powder poison made from a plant. It kills both by being eaten and by contact. It can be used as a powder to be dusted on to the plant either full strength or diluted with flower, or as a liquid, one pound Hellebore to 40 gallons of water, to be sprayed on the plant. It costs about twenty-five cents per pound. It is used

less extensively than Paris green or London Purple, but is especially excellent in destroying the currant worm.

White Arsenic is not to be used when Paris green or London purple can be had, since it is dangerous to have about and is apt to burn the leaves.

EXTERNAL POISONS.

Pyrethrum is a powder made from the flowers of a plant and is very poisonous to insects, but is perfectly harmless to man and domestic animals. It kills insects by contact, and can be most successfully used as a powder to be dusted by means of a bellows or other powder dusting machine. *Pyrethrum* is hard to obtain pure or at least in a fresh condition. It loses its strength by standing, and should be kept well corked. It may be used as a spray in the proportion of one pound of *Pyrethrum* to 40 gallons of water. *Pyrethrum* is very useful for killing the cabbage worm, or insects destroying parts of plants that are ready to be eaten by man. It is also of great use in clearing rooms of flies, mosquitoes, &c., and fleas and lice on domestic animals.

Kerosene Emulsion is perhaps the best substance to be used for sucking insects. It is made as follows: "Dissolve one-half pound of hard soap in one gallon of boiling water, and while the liquid is still hot, but not near a fire, add two gallons of kerosene. The whole is then violently churned until it forms a creamy mass, which will thicken into a uniform jelly-like mass on cooling, and the oil remains incorporated in the mass, and will not separate or rise to the top. The churning can best be done by means of a force pump with a small nozzle, pump the liquid back into the vessel containing the liquid. The emulsion thus obtained will keep indefinitely." When ready to use, thoroughly mix one part of the emulsion with nine parts cold water. This is to be thrown in the form of a spray on the plants, by means of some kind of a force pump and spraying nozzle. (See machines.)

The kerosene emulsion will injure no foliage, and since it

kills insects by contact, it is the most effectual remedy against the chinch bug, plant lice, bark lice, melon bug and other sucking insects, and also for the cabbage worm, and white grub, and will even kill eggs in some cases. It is of the greatest importance that the emulsion be forcibly, thoroughly, and evenly applied, as can be done only by the use of some force pump arrangement.

Kerosene may be used without the trouble of making an emulsion with soap and water, and, so far as my experience goes and from what I can learn of others, with equal results to the soap emulsion. This is rendered possible by using a force pump that will mechanically mix the kerosene with the water at the instant of spraying. One can readily see what an immense saving of time and trouble this will effect. The best machine to use in this connection is the Perfected Galloway Knapsack Spray Pump with kerosene attachment, made by the Deming Company, Salem, O. or the one made by the W. & B. Douglass Company, Middletown, Conn. (See figure under machines for applying poisons.) The water is placed in the usual reservoir and the kerosene in an additional reservoir attached to it. The proportion of kerosene to the water can be regulated by a stop-cock. The kerosene is thoroughly mixed in the pump and spray nozzle only when the pump is in action, otherwise the two fluids remain separate. This attachment does not interfere with the use of the pump for other purposes, since a stop-cock completely shuts off all communication with the attachment, which may also be removed.

Kerosene emulsion may have added to it a small amount of Paris green or preferable London purple and thus be converted into an insecticide for both biting and sucking insects. This method does away with the necessity of making two applications of insecticides. I find it better to first dilute the stock emulsion to the usual extent, and then to add the Paris green or London purple in the proportion of one-fourth pound to the barrel. To use the Paris green or London purple with the kerosene and water spray from the

knapsack sprayer, I thoroughly mix one-fourth pound of the poison in a barrel of water, and fill the knapsack sprayer with this mixture, and the attachment with kerosene.

Carbolic Acid Emulsion is made by adding Carbolic Acid (the crude material, dry to get a good strength) one part to 5 or 7 parts of the soap solution similar to that used in making the Kerosene Emulsion. The liquid is to be churned in the same manner as the Kerosene Emulsion, to form an Emulsion. This Carbolic Acid Emulsion is one of the best preparations to protect plants against lice and fruit trees against borers. It can be sprayed upon the trunks of fruit trees or rubbed on by means of a cloth. Every fruit tree should be treated in this way, especially the young trees, about two weeks after the trees blossom.

Tobacco Decoction is made by adding refuse tobacco, which can be obtained at small cost from tobacco factories, to boiling water, in the proportion of one pound of tobacco to two or three gallons of boiling water. As soon as the water has cooled, strain out the tobacco, and the decoction is then ready to use. It is to be sprayed upon the leaves, and is an effectual remedy against the striped flea beetle, and the cucumber, watermelon and squash flea beetles. It will also drive away some bugs from similar plants. It is also valuable as an insecticide against lice and ticks upon domestic animals, and has the advantage over Kerosene Emulsion in that it leaves the hair in better condition.

Bisulphide of Carbon is a liquid that is of great use in destroying the Phylloxera of grape, ants, insects in stored grain, and other insects which can be reached by means of a vapor. For Phylloxera and ants it is to be poured upon the top of the ground above them.

For grain insects and insects affecting clothing, it is placed in shallow dishes and kept in the closed room. The vapor from this liquid is extremely explosive, and must not be used in a room near the least trace of fire, even a lighted cigarette may cause a great explosion. Bisulphide of Carbon can be had from the manufacturer for from 10 to 12 cents per pound in 50 pound cans.

E. R. Taylor, Cleveland, Ohio, advertises Bisulphide of Carbon for ten cents per pound in fifty-pound cans.

MECHANICAL ARRANGEMENTS.

These are intended to act as barriers to keep away insects, or as traps to capture them. They will be described under the special insect which can thus be best treated.

MACHINES FOR APPLYING POISONS.

There are a great many kinds of machines and devices manufactured and sold by dealers for applying insecticides and fungicides, some of which are very good, and every farmer, fruit grower and gardener should have at least one. In order to save the purchaser time and trouble in making a selection, a few of the more important machines are here figured, together with the price and manufacturers address.

It is of course important, whenever possible, that one provide himself with two machines, one for using a powder, the other for syraying a liquid; but in case only one can be purchased, a force pump and spraying nozzle should be selected, since one can often mix the powder with the water and apply it in this way.

One of the best machines for dusting a powder on plants is Leggett's Powder-gun. It works by turning a crank, and throws the powder in a fine dust constantly and evenly, and the supply can be easily regulated so that one or one-half pound of Paris green or London purple can be evenly distributed over an acre. This instrument has been highly recommended by all who have tried it. The price of this gun delivered complete with four extra tubes, shoulder strap, oil can and all necessary attachments for distributing the powder is \$7.50. This machine can be purchased from the makers, Leggett & Bros., 301 Pearl St., New York. See fig. 1, 2, 3.

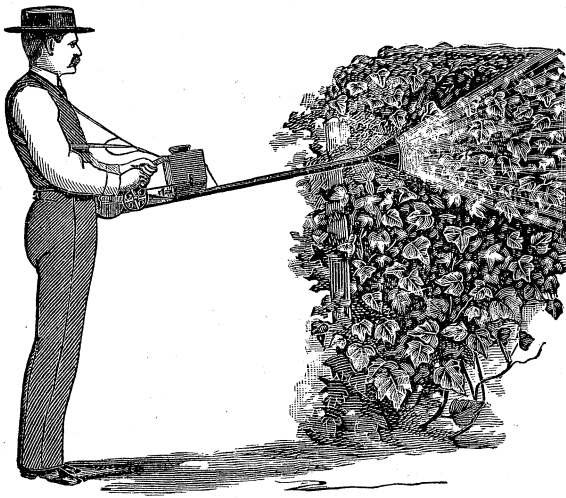


FIG. 1, 2, 3. Leggett Bros. Powder-Gun.

Another very simple and effective machine is Woodason's Liquid and Powder Spraying Bellows, of which four styles are made. The Double Cone Bellows for dusting Paris green, London purple or Pyrethrum, can be purchased for \$3.00, and will be found a very simple and economic machine. The liquid spraying bellows can be had for \$2.00. These machines will be found very useful, and are highly recommended. They are manufactured by Thomas Woodason, 2900 D. St., Philadelphia, Penn., or they can be purchased of H. A. Kuhus, Atlanta, Ga.

In the purchasing of machines for spraying liquids, three things should be taken into account. The pump should be made of such materials as will not be easily affected by the chemicals used, there should be some automatic device for keeping the liquid constantly stirred, and the spraying nozzle should be one that is not easily clogged and one that will throw a fine and uniform spray. There are many nozzles manufactured for this purpose, almost any of which can be purchased from a dealer in force pumps.

The names of some of the different spraying nozzles are "Masson," "Cyclone," "Vermorel," "Boss," "Graduating" and "Climax." Some of these nozzles, such as the "Boss" and the "Graduating," can be made to throw a fine or coarse spray, or a solid stream. They are all of value and range in price from a dollar to a dollar and a quarter.

There are many force pumps with spray nozzles manufactured for spraying liquids on plants; but my experience leads me to believe that for cheapness, durability, simplicity and effectiveness the pumps of The Deming Company, Salem, Ohio, are superior to all others. The "Success" brass spray pump for bucket is shown in fig. 4. I regard this as the best pump made for ordinary use, and it is extremely cheap. The regular catalogue price is \$6.00, but it can be had for \$4.00. In ordering, one should state that they wish a hole drilled in the suction casting for an agitator.

Where it is necessary to do a large amount of spraying,

the "Ideal" double-acting brass spray pump manufactured by the same company, and shown in fig. 5, should be used. The price of this pump varies according to the attachments from \$12.00 to \$18.00, exclusive of the barrel. This pump can be placed on any barrel and carried about the field in a wagon.

This company, and also the W. & B. Douglas Co., Middletown, Conn., manufacture a "Knapsack" spray pump with an attachment for kerosene. By means of this attachment one can save much time and trouble in not having to make a regular kerosene emulsion, since the water and kerosene are mixed in the act of spraying. These pumps are a great convenience, but they are rather costly for most farmers. Fig. 6 shows one of these pumps made by The Deming Co. The price with the kerosene attachment is \$18.00 in the catalogue, but they can be had for \$15.00,

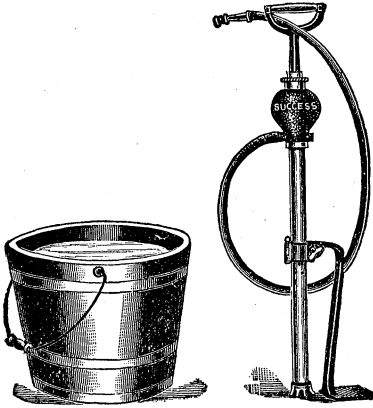


FIG. 4. "Success" brass spray Pump for Bucket.

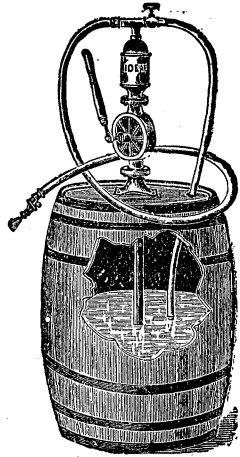


FIG. 5. "Ideal" double-acting brass spray pump mounted on barrel.

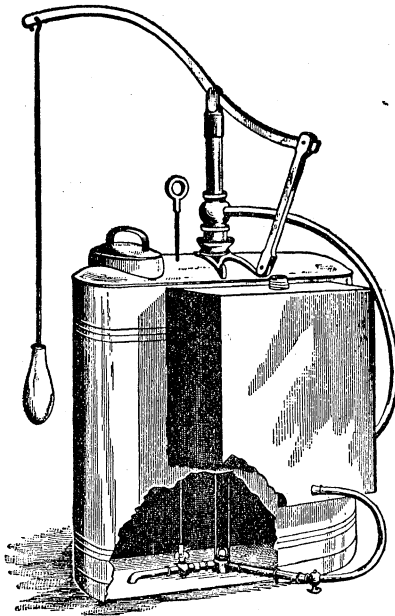


FIG. 6. The Perfected Galloway Knapsack sprayer with kerosene attachment.

INSECTS INJURIOUS TO STORED GRAIN.

THE PEA WEEVIL.

(*Bruchus pisi*, Linn.)

The pea weevil is a small beetle about three-sixteenths of an inch in length. It is of a dull gray color, with a few markings on the back and occasionally a white spot on the thorax. Figure 7 shows this beetle in its different stages enlarged, and with the natural size figures near them. The

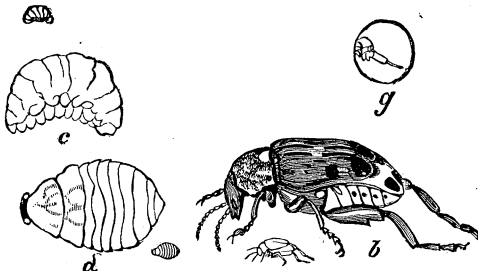


FIG. 7. Pea weevil; b, adult; c, full grown larva; d, pupa; g, pea showing exit hole. Natural size indicated by smaller figures.

adult beetle lays her yellow colored eggs singly on the outside of the young pea pod. As soon as the eggs hatch, the small larvæ bore through the pod and enter the peas. Here they feed, avoiding as a rule the germ, until full grown, when they cut a hole nearly through the seed coat, leaving a thin membrane over the burrow. The larvæ then turn to the pupa stage. But one insect can, or at least usually does, develop in a single pea. The adult beetle issues either in the fall or more commonly in the spring.

THE BEAN WEEVIL.

(*Bruchus obtectus*, Say.)

The bean weevil is a small brownish beetle a little over one-eighth of an inch in length. It resembles very much

the pea weevil, and has much the same life history and habits. Figure 8 shows this beetle enlarged at *a* with a natural size figure near it, and an effected bean at *b*. The

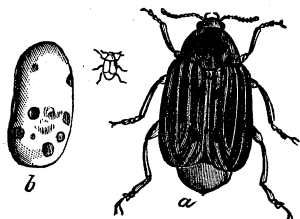


FIG. 8. Bean weevil; *a*, adult; *b*, damaged bean. Natural size shown by smaller figure.

female beetle deposits her eggs in clusters, either in a slit or hole made with her jaws in the pod, or else in the split caused by the partial drying of the pod. The eggs are most abundantly found in fully developed or partially dried pods, where the seeds are fully matured. The young larvæ enter the beans, and make circular mines in them while feeding upon their substance. Unlike the pea weevil, only one of which is found in a single pea, the bean weevil may occur in considerable numbers in a single bean. When the larvæ are fully grown, they bore a hole to the outer skin of the bean, and then turn to the pupa stage. When the adult beetles emerge, they will deposit their eggs in the stored grain, and thus multiply and damage the beans continually. Hence when these insects once infest stored beans, it is necessary to kill at once all the insects, or they will completely ruin them. The number of generations varies, and thus one finds these insects in all stages in the stored beans. The bean weevil is very troublesome in cow peas also.

THE FOUR-SPOTTED BEAN WEEVIL.

(*Bruchus 4-Maculata*.)

The four-spotted bean weevil is a little larger than the pea weevil, and can be distinguished from it by the presence of four black spots on the wing covers. The habits and life histories of this insect are similar to the bean weevil, and therefore will not need describing here. The four-spotted bean weevil is extremely troublesome and injurious to our cow pea, perhaps even more so than any other weevil. I

find it next to impossible to purchase cow peas that are not infested with them. I regret that I have no figure of this insect.

THE GRAIN OR CORN WEEVIL.

(*Calandra granaria*, Linn.)

The grain or corn weevil is a dark brown or black beetle about three sixteenths of an inch in length. This weevil can be distinguished from the grain beetle, which also infests corn, by its stouter body and by the presence of a long snout, which is wanting in the grain beetle. Figure 9 shows the grain or corn weevil enlarged at *e* and with a natural size figure just above. The snout can be readily seen by glancing at the figure. The female beetle deposits her eggs singly upon the corn, and also upon wheat in some cases. In a few days the eggs hatch, and the small larvæ enter the corn, and feed upon and burrow through it. The full grown larvæ transform to the pupa stage within the kernel. The adult beetles emerge by cutting a hole through the skin of the kernel of corn or wheat as the case may be. An ear of corn infested with these weevils will be full of holes, showing where the adult beetles have emerged.

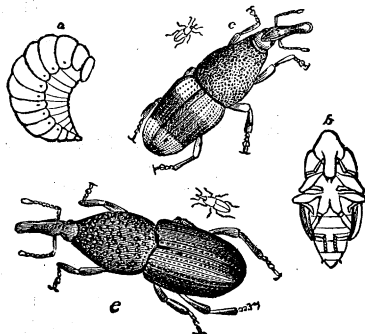


FIG. 9. e, Grain or corn weevil; c, Black or rice weevil. Natural size shown by smaller figures. a, larva; b, pupa.

THE BLACK OR RICE WEEVIL.

(*Calandra oryzae*, Linn.)

The black or rice weevil is a black colored beetle with four reddish brown spots on the wing covers. It is somewhat smaller than the grain or corn weevil, being about one eighth of an inch in length. Figure 9 shows this beetle enlarged at *c* and with a natural size figure just above.

As the name indicates, this beetle is frequently found in rice, but it attacks corn and wheat as well, and does its greatest amount of damage to corn in this state. The adult female makes a hole in the grain with her mouth parts, and deposits an egg in it. Frequently more than one hole and egg is deposited in a single kernel. The larvæ burrow and feed upon the inside of the grain, and when full grown change to the pupa stage within the kernel. The adult beetles soon emerge and deposit eggs for another brood. In infested corn, one can find these weevils in all stages of development. The adult beetles are also very injurious in a direct way, in that they will eat into the kernels of corn for a short distance themselves, and are not content with a single kernel. An ear of corn infested with the black or rice weevil will soon be ruined, nearly every kernel having holes eaten into it, and its interior more or less eaten away.

THE ANGOUMOIS GRAIN MOTH.

(Gelechia cerealella, Oliv.)

The angoumois grain moth is perhaps the most destructive insect affecting our grain. It was introduced into this country sometime before 1728 by the earlier settlers of Carolina and Virginia, who brought it with them from

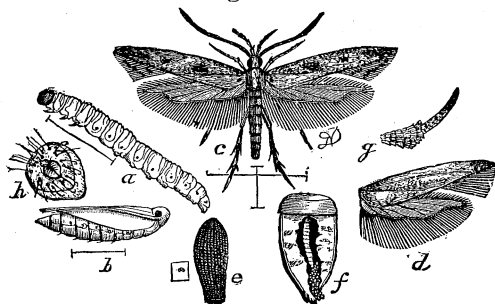


FIG. 10. Angoumois Grain Moth; a, larva; b, pupa; c, adult; d, wings; e, egg; f, kernel of corn showing work of larva; all enlarged except f.

Europe. The original home of the moth is supposed to be South Europe, although it seems to have attracted popular attention first in Angoumois province, France, where it caused immense damage and nearly resulted in a famine. This insect is more destructive in the Southern States than in the Northern, and attacks corn and wheat not only in the granary, but also in the field. It is also said to attack cow peas, oats, and barley. This grain insect is all the more destructive from the fact that it will breed readily in confinement; and if once introduced into a granary and left to itself, it will entirely destroy it.

The angoumois grain moth is a small fawn or light gray colored insect, measuring about one-half an inch across its expanded wings; it has a shiney appearance, and the hind wings have a feathery edge. The adult moth is represented somewhat enlarged at c figure 10, and natural size by the cross lines just beneath. A greatly enlarged egg is shown at e; the larva at a, with a line beneath representing the natural size of the fully developed larva; and at b the pupa is figured enlarged, with the natural size indicated by the line just beneath.

The original home of the moth is supposed to be South Europe, although it seems to have attracted popular attention first in Angoumois province, France, where it caused immense damage and nearly

The female moth deposits her eggs on the grain in the field or in the granary. The eggs may be deposited singly or in

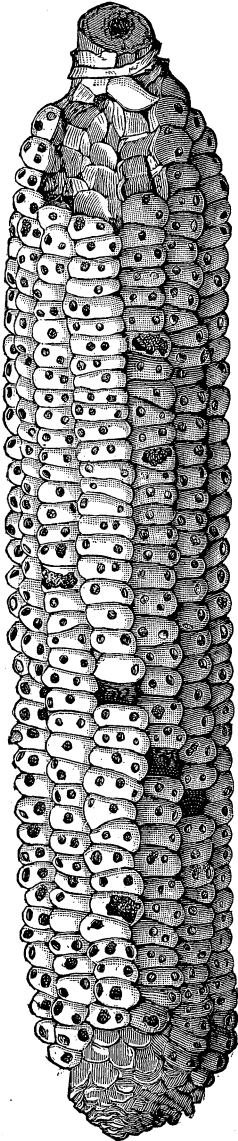


FIG. 11. Ear of corn showing work of the Angoumois Grain Moth.

clusters just under the thin membranes at the base of the kernel of corn or between the rows. The eggs hatch in a few days into minute active larvæ, that are frequently seen suspended by a delicate silken thread. They soon find a tender place and enter the kernel of corn or wheat. The hole in the grain made by their entrance is so small as not to be readily noticed, or it may be closed up with excrement. The larvæ mine and feed upon the interior of the grain, and in some cases leave only the outer coat intact. When full grown, they cut a circular hole through the skin, but do not disturb the plug. They then spin a delicate cocoon within the kernel, and inside of it turn to the pupa stage. In a few days or weeks, according to the climate, the adult moths appear and lay the eggs for another brood. But one larva is found in a grain of wheat; but two or more may occur in a kernel of corn. The number of broods per year varies from two in the northern states to seven or eight in the southern states. In this state one can find the insect in all stages in infested granaries.

The appearance of an ear of corn after the moths have emerged is shown in figure 11. Grain

infested with these insects to any considerable extent will not germinate, will loose considerably in weight, and is not wholesome as food, but may even be injurious. When these insects are found in stored grain they should be exterminated at once, since they multiply with such rapidity that they will completely ruin all the grain in a short time.

THE GRAIN BEETLE.

(*Silvanus surinamensis*, Linn.)

The grain beetle is a small reddish brown colored insect, a little over one-eighth of an inch in length. It can be distinguished from the other grain beetles

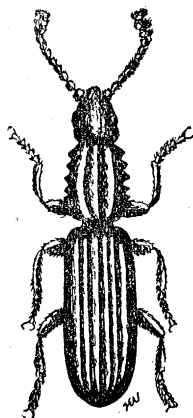


FIG. 12.
Grain Beetle.

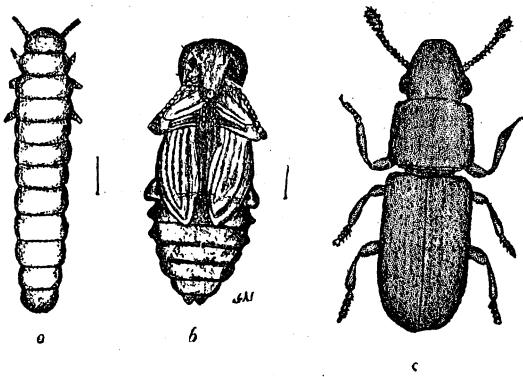
by its more cylindrical form, and the presence of saw-like teeth on the margin of the thorax; it also has three longitudinal ridges on the thorax, and several less distinct on the wing covers. See figure 12, which represents this beetle much enlarged.

This beetle is found in granaries usually in connection with other grain insects. The adult beetle as well as the larvæ feed upon corn or wheat, and do not confine themselves to a single kernel. The larvæ often pupate in the cracks about the granary.

THE RED GRAIN BEETLE.

(Silvanus cassiae, Reiche.)

The red grain beetle is a small flat reddish brown insect, about one-ninth of an inch in length. The adult beetle is



represented as enlarged at c figure 13; the pupa at b; and the larva at a. The lines at the side of each shows the natural size.

These beetles infest corn more particularly.

FIG. 13. Red Grain Beetle; a, larva; b, pupa; c, adult. All enlarged.

The eggs are deposited at the base of the kernels, either in the field or in the bin. The larvæ enter the kernels, and feed as a rule only upon the softer lower portion; and when mature make their pupæ within the corn. More than one larva may develop in a single kernel. There are several broods each year; in some localities as many as nine. The beetles are quite lively, and will seek shelter when disturbed; the larvæ rarely make their presence known, and as a result these insects often remain unobserved until they have accomplished considerable damage.

THE BROWN GRAIN BEETLE.

(Tribolium ferrugineum, Fab.)

The brown grain beetle is, as its name implies, a brown colored beetle about one-eighth or three-sixteenths of an inch long. It is represented enlarged in figure 14. It is usually found in stored grain in connection with other grain insects, but may become quite common in neglected granaries. It also feeds upon dried animal matter, and is sometimes found in museums, and in the kitchen store room.

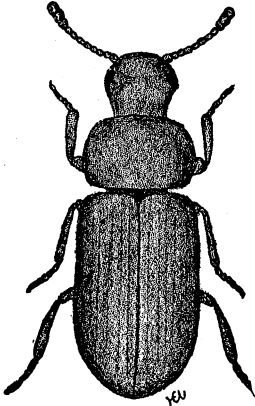


FIG. 14. Brown Grain Beetle. Enlarged.

The corn-sap beetle is about one-seventh of an inch in length, of a dark brown color, with the wing covers lighter in color and not extending to the end of the abdomen. An enlarged beetle and larva is represented in figure 15, with the natural size indicated by lines at the side.

This beetle, like most of the beetles belonging

THE CORN-SAP BEETLE.

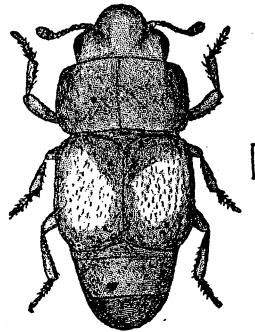
(Carpophilus fallipennis, Say.)

FIG. 15. Corn Sap-Beetle. Larva and adult, enlarged.

to the same family, are not very destructive to healthy vegetable products, but prefer injured or decaying vegetable matter. They are to be found in injured cotton bolls, in heaps of decaying cotton seed, in decaying fruit of all kinds, and sucking the juices from injured fruit and trunks or limbs of trees. I have found them in the ear of corn only when such ears had been previously injured by other cause. It has been stated, however, that they will attack healthy kernels even in the bin; but I am inclined to think this would not occur if they had not been introduced there in the larvæ stage in diseased corn, and after eating that, were forced to eat the healthy kernels.

REMEDIES.

The best remedy in every respect for killing grain insects is *bisulphide of carbon*. It is cheap, effectual, and easy to apply. Bisulphide of carbon, or the new fuma bisulphide of carbon, can be obtained of the manufacturer, Mr. E. R. Taylor, Cleveland, Ohio, in fifty pound cans for ten cents per pound, or in smaller quantities at a little more per pound.

One pound of the bisulphide of carbon is ample for one hundred bushels of grain, provided it be in a comparatively tight bin or granary, and the grain is not in the husk or pod. If the bin or granary is quite open and contains many holes, it will be necessary to use more bisulphide of carbon, since it will evaporate and escape. The holes should be closed as much as possible. The grain should not be stored in the pod or husk, since it is almost impossible for the fumes of the bisulphide to penetrate through the husk of an ear of corn, and much less through the pod of a bean or pea.

In view of the fact that many grain insects attack the grain while it is in the field, and are thus carried directly into the granary, it is advisable to make one application of the bisulphide of carbon immediately or very soon after the grain is gathered and stored. The grain should then be ex-

amined at least once a month, and if there appear signs of insects, it should receive another application. Then in the spring, before the grain is taken out for planting, it should always receive an application of bisulphide of carbon, to be sure that all insects are destroyed and thus prevented from attacking the grain in the field and multiplying there.

The bisulphide of carbon is best, or at least as well, applied by sprinkling it over the top of the grain. It will soon evaporate, and as the fumes are heavy they will penetrate through the grain. The germinating properties of grain are not injured in the least by any ordinary application. Some may prefer to saturate cotton with the bisulphide and place it in the grain, or to fill shallow dishes and place them about the granary. No harm can result, however, from sprinkling the bisulphide directly on the grain, since it evaporates almost immediately, and if pure, leaves no trace of it on the grain. One can test the bisulphide of carbon to determine whether it is pure or not, by dipping a black feather in it and allowing it to dry; if the bisulphide is pure no residue will be seen.

The only precaution in the use of bisulphide of carbon is not to have the least trace of fire about; the fumes are very explosive and will ignite from a lighted cigar or lantern.

Bisulphide of carbon evaporates so rapidly that it will disappear in a few moments, if some of the grain be removed to the open air.

It is not necessary to mention any other remedy for insects in stored grain as the above is much superior to all others.

J. M. STEDMAN,

Biologist.