EXPERIMENT STATION

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HORTICULTURAL AND ENTOMOLOGICAL DEPARTMENT.

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SOME INSECTS INJURIOUS TO THE ORCHARD.

Few have time to devote to the study of insect life, yet our enemies the insects play such an important part in farm economy that it is essential to give to the public, from time to time, more information of a practical nature, regarding their habits and the methods of combating them. This the horticultural and entomological department of the Kansas station proposes to do. In this bulletin the following subjects are treated viz:

Canker-Worm *(Paleacrita vernata.)*
Codling Moth (*Carpocapsa pomonella*.)
Tent Caterpillar *(Clisiocampa Americana.)*
Plum Curculio *(Conotrachelus nenuphar.)*
Plum Gouger *(Coccotorus scutellaris.)*
Peach Tree Borer (*Sannina exitiosa.)*
Flat-headed Borer *(Chrysobothris femorata.)*
Round-headed Borer (*Saperda candida*.)
The San Jose Scale *(Aspidiotus perniciosus.)*
Elm Twig-Girdler (*Oncideres cingulatus.)*

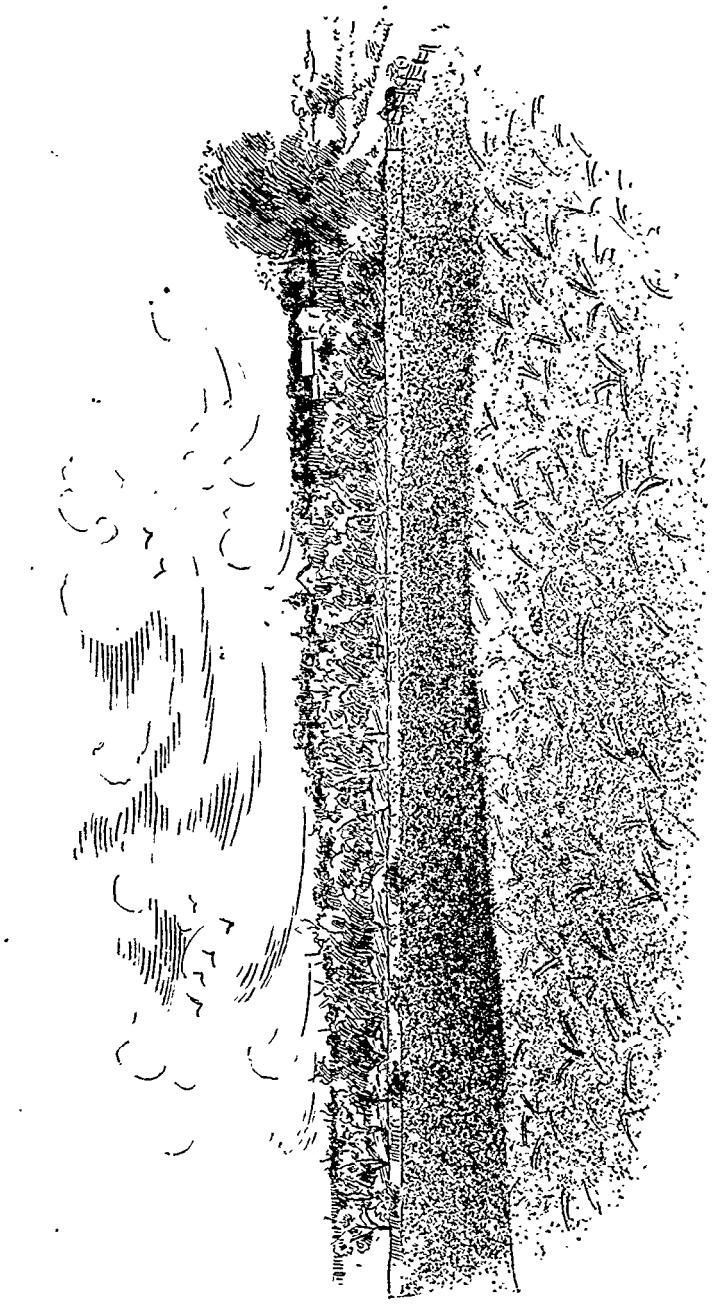
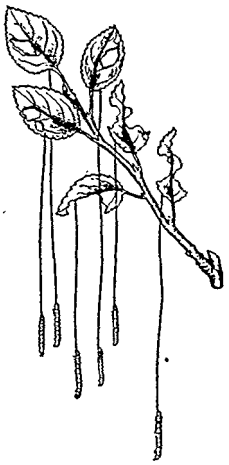


FIG. 1. AN ORCHARD DEFOLIATED BY CANKER-WORM.

INTRODUCTION.



The ravages of insect pests upon the farm, orchard and garden in this state have long been economic questions; these insects have increased in number and species with great rapidity until there is scarcely a plant grown or a crop harvested on the farm but what has at least one insect enemy. The steady encroachments of these pests year by year have alarmingly and materially reduced the revenues of the farming interests of the state.

Insects are introduced from one locality to another in numerous ways: by improved methods of transportation, by the denuding of forests, the neglect of orchards and farm lands which serve as breeding grounds, the changing of food habits from time to time and because of the rapid multiplication of most insects. These facts emphasize the necessity of a more thorough knowledge of the common injurious insects, as to their habits, how and upon what they feed and the best ways and means for their prevention and destruction. While the study of insects as a science is a complex one, there are a number of general principles regarding the structure of insects which if understood are helpful in combating their depredations and often lead to a more minute study of the insect world. Each insect has its own peculiar habitat and means of subsistence,—no two species may be said to be alike in this regard. The complete stages in the life of insects are four; the egg, larva, pupa, and adult. In their method of eating, insects may be divided into two general classes: those with mouth parts arranged to work horizontally so as to chew their food, and those which suck up the juices of the plant by means of a tube or proboscis which is pushed into the tissue of the plant.

It is plainly seen that each class requires a different treatment for its destruction. For those which chew their food some substance of a poisonous nature should be applied in such a manner that the insect will devour it with its food. With sucking insects this treatment is useless because of their pushing their sucking tubes through the poisons and taking up the juices of the plant beneath.

In such cases measures should be adopted which will either destroy the tissue of the insect or stop the action of the respiratory system of the body. The method by which food is taken up by the insect is one of the key notes to observe in its treatment. In the destruction of injurious insects, agents in form of diseases and natural enemies or parasites have proved of great value in some instances. Yet these same beneficial agents likewise have common enemies, so that artificial agents are necessary,—the success of which is dependent upon prevention by cleanliness of orchards and the thorough and proper application of insecticides. In this work, spraying has become to the orchardist an important factor in protecting his crops. Yet this, operation is looked upon by many as uncertain in results. This view is largely deduced by observing the effects of a preceding year, instead of from a series of years, also from a lack of information regarding proper remedies and their economic application. Such views held, have done much to call in question the value of spraying, as observed in instances where properly done and where it has resulted in valuable returns. Success in spraying means definiteness of purpose, thorough and careful application.

The insects with which the agriculturist has to contend in the varied lines of work on the farm are usually confined to a certain few, whose depredations have become more noticeable, for which anxiety is shown and information requested. It is in the line of the treatment of common insects met on the farms of this state that the station is studying. The injurious effects of insect pests which are at present commanding the attention of fruit growers, shown by data and numerous inquiries, have prompted the publication of this bulletin, with spraying calendar appended. That there is need of such information may be seen by the following table comprising results of data collected from 103 counties of the state in reference to the preceding year's crop, showing the depredations of the following insects upon the orchards of the state:

Name of Insect.	No. reports indicating damage	Counties represented.	Reports on spraying or treatment.			Reports on no spraying or improper treatment.
			Unsuccessful.	Successful	Total.	
Canker-worm	174	46	37	57	94	80
Codling moth	164	42	32	56	88	76
Tent-caterpillar	110	27	19	40	59	51
Curculio	146	32	34	45	79	67
Gouger	36	8	7	12	19	17
Peach borer	114	31	27	5	32	82
Apple-tree borers	160	37	28	15	43	117

In reviewing the reports which form the above table it is to be observed that the insects treated are well distributed throughout the fruit districts of this state; spraying as treatment being only a partial success, the failure being due to an improper knowledge of the method of attack by the insect or the improper use of insecticides. From over 400 reports received from the leading fruit growers of the state, fruit growing is reported as being greatly on the increase. Where decline was reported insect destruction in most cases played an important part.

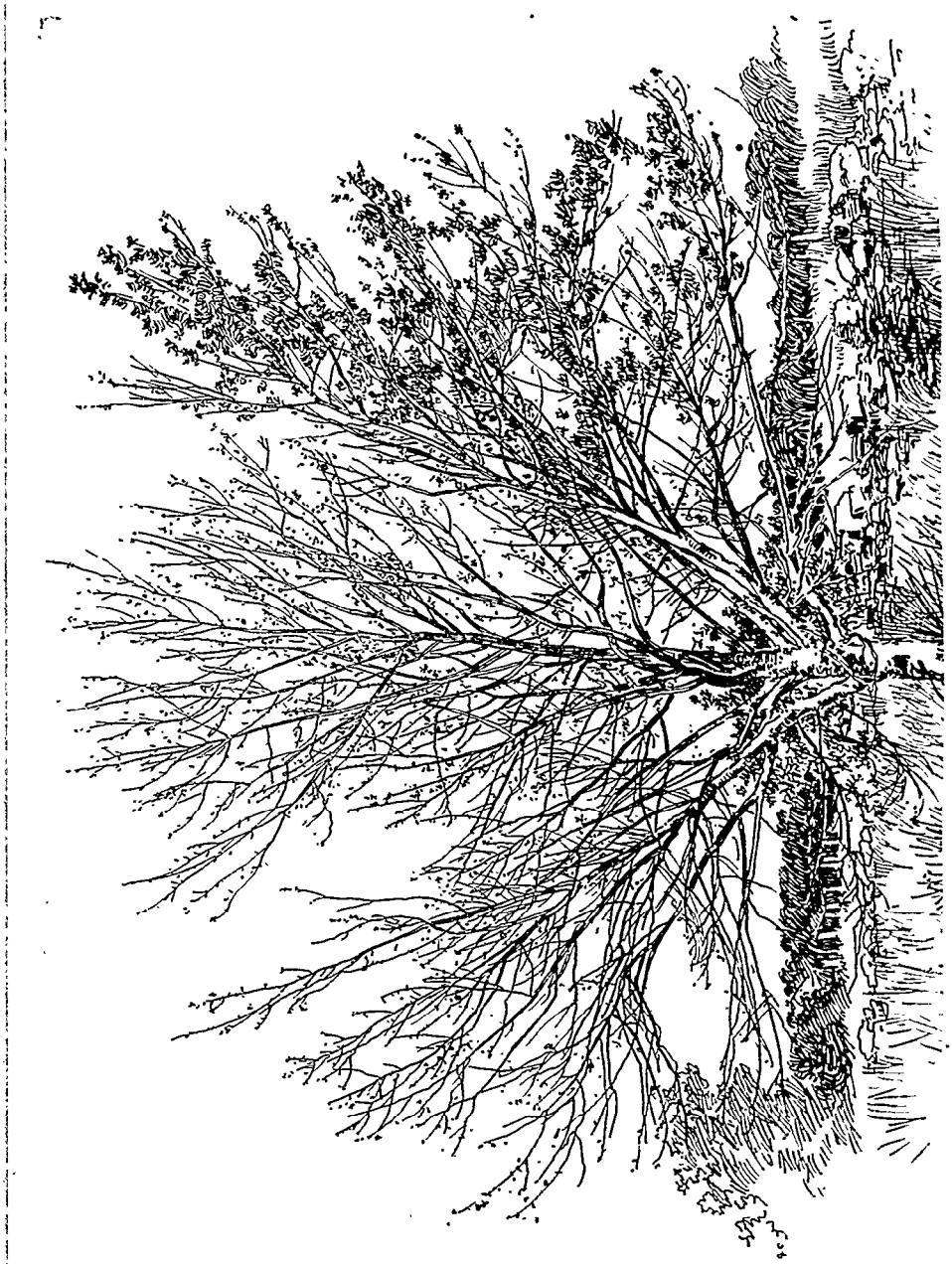


FIG. 2. AN ISOLATED TREE DEFOLIATED BY THE CANKER-WORM.

THE SPRING CANKER-WORM.

(Paleacrita vernata Peck.)

The injuries sustained in Kansas by the ravages of the Spring Canker-worm extend over a series of years, showing a steady growth and spread of the pest into fruit sections until within the last three years it has become one of the leading orchard pests. Yet notwithstanding this great loss to orchards each year, many fail to realize the importance of combating the insect until it has begun its work of destruction. Trees not in leafing suffer from attacks by the loss of leaves; although the injury to new foliage may seemingly be offset by the putting out of later foliage, still a loss must be sustained by a checking of the growth of the tree. Where entire defoliation has taken place three times in succession the tree is practically ruined. When trees are in a state of bearing the drain on the vitality is even greater.

The injury done by Canker-worms is not all confined to fruit trees but they attack a number of our valuable forest and shade trees. At the station during the past season oak, elm, ash and catalpa sustained severe losses. In the orchards, the apple, peach, plum, cherry, apricot and quince suffer the most severe ravages. The leaves when first attacked become perforated with small holes; these increase in size as the leaves develop, until finally the pulpy parts of the leaves are devoured, leaving the skeleton of the leaf, comprising the mid-rib, veins and stems, giving to the trees an appearance of having been scorched by fire, as shown in Fig. 2.

The eggs of the Canker-worm are oval-shaped, yellowish, with a pearly lustre, and are deposited in irregular clusters or masses on twigs, or at base of large branches. (Fig. 3.) A favorite place is in the brown leaf masses, formed by larvae of Phycis indigenella "leaf-crumpler;" in these clusters quantities of eggs are often found, also in cavities formed by fruit spurs. In a badly infested apple orchard near the college grounds during the past season scarcely a single spur could be found without eggs. This is undoubtedly the objective point of the female, bringing the young larvae upon hatching in close proximity to the tender, expanding leaves. Egg masses mere found in the cavities formed by the larvae of the Codling-moth in apples left on trees during winter. The aim of the female moth seems to be to deposit eggs in concealed or protected places. The time required

for the eggs to hatch is dependent upon the temperature. Eggs found March 9, 1897, were placed in a warm laboratory and hatched in ten days. Under the same conditions, eggs were deposited in the laboratory by the female moth, Jan. 9th, from which the first appearance of the larvae was March 8th. After Jan. 9th, eggs were not laid until Feb. 12th, when from that date, eggs were being laid continually in the breeding cases. Half grown larvae were found out of doors March llth, however it was not until April 2d that eggs in the orchards began to hatch in considerable numbers. From March 9th to April 2d, the average temperature during the day was thirty-two degrees Fahr., maximum, fifty-one degrees Fahr. and minimum three degrees Fahr. During this period there were various changes in temperature, from low to high, intermingled with warm rains, snows and blizzards. From April 2d the larvae became more numerous. On April 16th they were doing great damage, feeding ravenously; and a few days later in some untreated orchards scarcely a green leaf was to be seen, larvae were still hatching so that all stages of development were noted, varying from one-eighth of an inch to one and one-fourth inches in length, of a dark, olive green color, with black, shining heads when young, changing slightly with the different moults (Fig. 4.) Myriads were observed suspended by silken threads of various lengths.

FIG 3.
a. Eggs deposited
b.Eggs mass

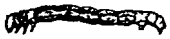


Fig.4. Larva.

The larvae pass to the ground, in some cases in rubbish or under leaves either by crawling down the trunk of the tree, looping their bodies or by lowering themselves by the silken threads. On May 4th, nearly all of the larvae had passed into the ground and by May 20th all were gone. Data from records of previous years as to pupation show a slight variation due to early and late springs. In this pupal or chrysalid state the insect remains until the warm days of spring or late winter; occasionally a moth may appear which should serve as an indicator of coming trouble.

The adult (male) is a brownish gray moth with a spread of wings of a little more than an inch—front wings are brownish white, the hind wings are a pale, ash color much lighter than the former. An interrupted white band crosses the anterior wings near the outer margin. The female is wingless, the body of a grayish brown color and more robust than the male. The moths issue early in the spring from the chrysalides in which state they pass the winter, occasionally emerging during a warm period.

FIG. 5. ENTIRE DEFOLIATION OF AN APPLE TREE.

FIG. 6. AN APPLE-TREE NEARLY DEFOLIATED.

Male moths have been observed in November and December. From tabulated data taken by the department from a series of experiments in breeding cases, it was found that the numerical proportions of the emerging of male and female were about the same. From a collection of 1101 chrysalides, 560 males and 541 females emerged; the daily tabulations of each being remarkably even. Males were seen flying about on Jan. 8th. On Feb. 20th, they appeared quite numerous, and on March 8th in swarms. Another species of Canker-worm is the Fall Canker-worm *(Anisopteryx pometaria)* differing but slightly in general description from the "Spring Canker-worm." The moths emerge chiefly in the fall and deposit eggs,—the larvae hatching at the same time as Spring Canker-worms. The Canker-worm has a number of enemies, found in certain parasites which feed upon the eggs and larvae. Birds are helpful agents in destroying eggs and larvae and should be welcome guests in the orchards.

FIG. 7.
Adult Male.

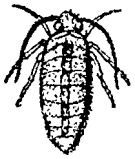


FIG. 8.
Adult Female.

Remedies: In combating the Canker-worm two methods are employed, both of which when used intelligently afford ample and effectual protection. The first measures to be taken are those to prevent the ascent of the wingless female. This can be done in two ways: first, to entangle her feet so she is held: second, to prevent ascent past a certain point on the trunk, so that after numerous unsuccessful attempts she dies from exhaustion. In the first, a number of substances are used of a sticky nature, comprising such mixtures as printer's ink, pine tar, "dendrolene," "raupenleim" etc, which are smeared on bands of heavy paper or canvas which are lightly bound around the trunk of the tree, making the bark as smooth as possible so as to avoid having crevices between the band and tree. These bands should be put on during the first mild days of early spring, the sticky substances should be often renewed by addition of fresh material, especially during rainy periods. If applied directly to the trunk some of the substances recommended tend to injure the tissues of the tree. However, excellent results have been obtained in treating full bearing trees with a mixture of resin and castor oil at the rate of three pounds of resin (white) to two pounds of castor oil. Melt these together without boiling and apply as a band directly to the trunk of the tree. This mixture is very lasting, and efficacious. The sec-

ond method is by means of collars of tin, paper, etc., so fastened to the tree as to admit of no passage ways at the collar. Ordinary carpet paper, made with a flange at the lower side was used by the department during the last season with success. Wire netting as a substitute has been suggested and will be tried during the coming spring. The second measure to be enforced is the use of the arsenical poisons applied in the form of sprays. There is a disposition among many of our fruit growers to disparage the use of poisons, due largely to the reasons that they have not been properly applied, or that the poisons were adulterated. The most universal remedy used in spraying for the Canker-worm is Paris green at the rate of one pound of Paris green to 150 to 200 gallons of water. The mixture should be thoroughly stirred while the spray is being applied evenly. Avoid drenching the foliage but give a fine, misty spray until leaves are well covered with mixture, usually indicated by slight drippings from the foliage. When the Canker-worm is about half grown the mixture does not seem to be as efficacious, often of little use, and in many cases results in the increasing of the proportions of the poisons by the operator, resulting in the scalding of the leaves; such observations have been made in many parts of the United States and Canada and certainly involve the necessity of early and repeated sprayings. Other arsenical mixtures, containing a higher percentage of pure arsenic are being used with favorable reports, and owing to their cheapness are considered valuable. It is, however, to be understood, in using these solutions, that they are considered as violent poisons and treated as such. Vessels in which mixtures are made and stored should be used for no other purpose. In the spring of '97, in addition to the Paris green solution, trees were treated with the formula, recommended by Prof. Kedzie, made as follows:

2 lbs. of White Arsenic,
4 lbs. Sal Soda,
2 gals. of Water.

The mixture was boiled until the milky color disappeared or the arsenic was dissolved. One pint of this was added to forty gallons of water thus forming a soluble arsenic insecticide.

By adding 2 lbs. of lime to forty gallons of water, in which was placed one pint of the above stock solution, a white, precipitate was formed, making an insoluble arsenic mixture, requiring thorough stirring while applying the spray. In using the above solutions viz: Paris green, soluble arsenic solution and insoluble

arsenic solution the following data were collected. The trees under treatment were affected by the Canker-worm in about the same proportion, the insect being thoroughly established. The experiment showed the following summarized results:

I. Trees sprayed with Paris green were not scalded, loss from the work of larvae from one per cent to five per cent.

II. Trees sprayed with soluble arsenic solution showed leaves scalded five per cent, larvae completely destroyed.

III. Trees sprayed with insoluble arsenic solution showed leaves free of scald, one per cent of leaves destroyed by larvae.

CODLING-MOTH.

(Carpocapsa pomonella Linn.)

Of the insects attacking the apple, none perhaps on the average is more destructive to the apple crop on this continent than this pest. Though only introduced into this country at the beginning of the present century it has spread to nearly all parts of the fruit districts of the United States and Canada, and like many other injurious insects introduced from abroad, its new surroundings seem to have been especially conducive to its development The ease with which the larvae are carried in fruits upon which they feed has caused its rapid and extended spread, causing an enormous loss each year to the horticulturist.

The adult (See Fig. 9)is a small moth with an expanse of wings of three-fourths of an inch, the front wings marked with alternate wavy lines of gray and brown, with a large oval, brown spot streaked with bronze or copper color on the hinder margin. The hind wings are of a yellowish brown. The moths appear about the first of May, and begin to deposit their eggs on the surface of leaves and apples, and in the calyx of the young fruit just setting. Prof. Washburn's observations in Oregon, also reports of observations made by Prof. Card of Nebraska and Prof.

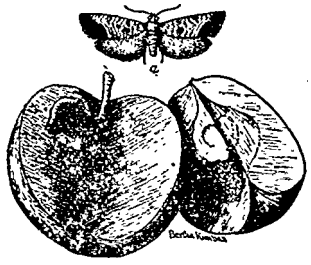


FIG. 9.
a. Female. b. Larva in apple.

Slingerland, of NewYork, *point to the greater percentage of eggs being deposited on the surface of apples and leaves, which is contrary to the opinion generally held by many that eggs were deposited only in the calyx.

This variation may be attributed to locality and environment. From reports these records do not hold good in all places. If, however, this becomes more universal, ease of combating will be greatly enhanced. The eggs hatch in about a week after they are deposited. When the larvae hatch from eggs not deposited in the calyx, they wander about on the surface of the fruit for a spot in which to conceal themselves, either at a point where two apples touch, or in the lobes of the calyx which are by this time closed tightly. From the point of entrance the larva commences to work its way to the center of the apple, where it bores around the core till full grown as shown in Fig. 9, also shown in infected peach, Fig. 10. It has also been found infesting prunes. As the fruit develops the larva increases in size. Its presence in the apple can generally be noted by the castings which exude from the point of entrance. In about three weeks from time of hatching the larvae leave the apple, and seek a hiding place in which to spin their cocoons. At this time generally, a large number of the infested apples have fallen to the ground with the larvae in them. But in some cases the larvae leave the apples while on the trees, and either crawl down the branches to the trunk, or let themselves down to the ground by a fine thread. The favorite place for them to spin their cocoons, however, is under rough bark on the trunk of the tree. Larvae when first hatched are very small scarcely an eighth of an inch in length, white in color, excepting head and first segment which are black. When mature the body receives a pinkish hue, and the head and first segment become brown. The adults issue from the chrysalides in about two weeks, appearing in this state about the middle of June. This brood commences to deposit eggs at once. From these, larvae hatch out, which pass the winter as such. These do not pupate, passing the winter as larvae within the fruit or in cocoons under bark or favorable, protected retreats. The fact that various stages of develop-

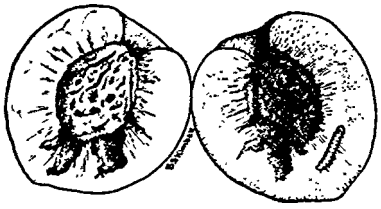


FIG. 10.
Larva in peach.

*Bull. 25 Oregon Exp Sta. Bull. 51 Neb. Exp Sta. Bull. 142 Cornell Exp. Sta., N. Y.

ment of larvae are found has led some to believe that there are several broods. This is due to the fact that some issue as adults in the spring later than others, consequently there is a difference of time in which eggs are deposited. This consideration accounts for the various stages of the larvae.

REMEDIES.

The most effectual method for combating the Codling Moth now in common practice is by spraying with arsenites, either Paris green or London purple, at the rate of 1 pound to 150 to 200 gallons of water and one pound of lime, which should be applied just after the blossoms have fallen and the fruit is setting. It is unnecessary to spray before this time; for it is not until after the blossoms fall that the moth appears to deposit her eggs. The chief object in spraying is to deposit a spray of poison within the calyx of the young fruit while in an upright position. This calyx cup is open but a short time after the petals have fallen, closing shortly. Spraying after this period to reach this end would be useless. Do not wait until the fruits are the size of cherries before treatment but spray with a fine spray at the right time to reach the early and late blooms. The larvae enter the apples chiefly by way of the calyx, eating into the fruit. (See Fig. 9.) Poison at this point furnishes an unhealthful meal. If spraying is interfered with by rainy weather, a second application should be made at once. It is often advisable to give two sprayings, varying a few days in application. As the second brood is derived from the first the early spraying serves a dual purpose. Methods for the collection and destruction of cocoons are often employed. Hiding places may be furnished which serve as a cover and are readily sought by the larvae. Bands made of coarse burlap or similar material are wrapped twice about the tree, forming folds within which the larvae conceal themselves and pupate. The writer has used excelsior with success. Bands should be put on not later than the first of June; an earlier period is better as larvae have been noticed in this climate moving down the trunk by the 20th of May. The surface of the tree above the band should be made smooth. Every week, bands should be examined and all worms and chrysalides destroyed. The larvae of the second brood generally pupate in cracks of barrels, old rubbish heaps and in parts of fruit houses where fruit has been stored. Cleanliness should be observed. The fruit houses and cellars should be thoroughly cleaned in the spring. All fallen fruit in the orchard should be gathered and destroyed.

APPLE-TREE TENT-CATERPILLAR.

(Clisiocampa Americana Harris.)

Among the insects found in the orchard none make their presence more noticeable than the tent-caterpillar by its large, white webs which are stretched in the angles formed by branching twigs and limbs. (See Fig. 11.) In these tents which are the work of the entire colony the larvae pass their time when not feeding, particularly at night and during inclement Weather. There are other species of tent-caterpillars confined to certain districts, the one most common being *Clisiocampa Americana.* The trees upon which they are usually found are the apple, cherry and plum; they are occasionally found feeding and spinning their webs upon the willow, poplar and oak which they defoliate. The insect has been quite prevalent during the last few years in Kansas, spreading into different counties. Since the insect is easy to combat the spread of the pest may be said to be due largely to negligence. If the caterpillars are left unmolested, they enlarge their web rapidly until large limbs become completely covered and defoliated. The moths appear in June, depositing eggs in clusters encircling the smaller twigs, containing from two to three hundred eggs in each cluster. The eggs are small, a little over one-twentieth of an inch in length, nearly conical in shape, often covered with a sort of varnish or glue almost enclosing them, holding them firmly together, and rendering them impervious to rain and moisture. The eggs do not hatch until the following spring, hence the above provision. During the warm days of April and May the larvae emerge from the egg masses, passing to the tender buds and leaves where they begin their work of devastation. The full grown

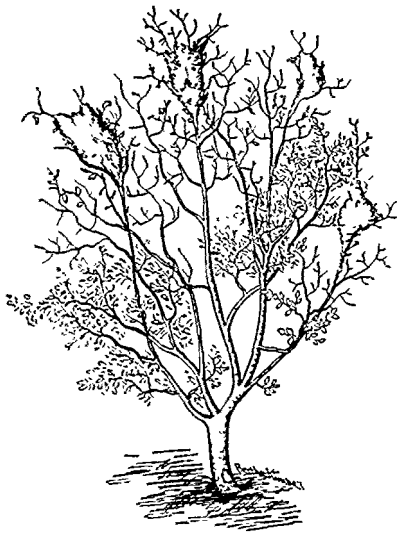


FIG. 11.
Tree showing work and webs of tent-eater. pillar.

larvae (Fig. 12) or caterpillars are nearly two inches in length, black, with light colored tufts on back, down the center of which there is present an almost continued white line, bordered by a number of interrupted, longitudinal, yellowish lines. The sides of the body are covered with lighter margins which are spotted with pale blue, the under surface of the body is black. The larvae issuing from the same mass of eggs occupy a common web and contribute their share to the formation of a common tent. The substance of which the tent or web nest is composed is a gummy substance which is secreted by glands, just back of the mouth. As soon as it is exposed to the air it dries and hardens. Immediately after they hatch they begin to spin for the formation of a common tent (Fig. 13); and wherever they are, they extend a thread by the accumulation of which the tree or limb is soon covered. An interesting feature in connection with the larvae is their regularity in feeding —usually appearing out of their tents once in the morning and once in the afternoon. The larvae are very voracious, and when present in considerable numbers often denude a tree of its foliage, leaving nothing whatever of the leaves except the larger veins and midribs, often rendering the tree as bare of foliage as it is in winter. The duration of the larvae is from four to five weeks, passiug through four moults. When full growth is acquired, they leave the tree upon which they have been feeding and depart in all directions in search of a sheltered place in which to spin their cocoons—generally selecting crevices in bark, fence posts and in rubbish piles, in fact wherever opportunities afford. Cocoons (Fig. 14) are oval, and elongated, having an outer silk web, which with its long, loosely woven threads gives the cocoon a very delicate appearance; the inner coat is closer and firmer in texture. In about three weeks the moth appears (Fig. 15) having an expanse of wings of one and one-half inches, (female); the male is slightly smaller. The moths are highly variable in color, varying from a yellowish to a

FIG. 12. Caterpillar

FIG.13
Tcnt with larvae.

reddish brown. The front wings contain two oblique, transverse, whitish lines, dividing the wings into nearly three equal divisions.

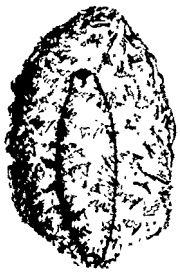


FIG. 14.
Pupa.

The moths are nocturnal and are often found flying in large numbers during the last half of June and early part of July. The moths do not feed, and after copulation the female deposits her eggs and dies.

Fig. 15.
Adult.

REMEDIES

The attacks on the mature larvae of a certain bacterial disease, together with a number of birds common to the state which feed upon the larvae are natural aids in their destruction. During the bright days of winter and spring the egg masses are easily detected on young twigs, which should be cut off and burned. The insects are so open to attack that there can hardly be any excuse for neglecting to destroy them. Since they cluster in their tents at night and rarely depart to feed before nine o'clock in the morning, the proper time to destroy them is during the clustering period. This may be done by taking a forked stick and twisting the larvae and web all up together. Other methods may be employed; in some instances gloved hands may be used. Burning with a frame from a ball of cotton soaked in kerosene is often employed. There is, however, danger of injuring the branches by excessive heat. The best remedy is to spray the foliage in the vicinity of the web with arsenite solutions. In spraying for the Codling Moth and other obnoxious leaf eating insects we apply sufficient poison to rid the orchard of this pest as well.

PLUM CURCULIO.

(Conotrachelus nenuphar Herbst.)

Much damage has been done to the plum industry in Kansas by the plum curculio. There is scarcely a plum orchard that has not received more or less injury. The insect, becoming as it has wide spread throughout the state, is undoubtedly the worst enemy of the plum grower. The adult (Fig. 16) is a small beetle

three-sixteenths of an inch in length. Its upper surface is rough with black, shining elevations; on the middle of each wing is a black hump. The general color is a dark brown with spots of ashy grey and ochre yellow. Although the plum suffers most from its attacks, the peach, prune, cherry, and apricot often receive severe attacks. The beetle passes the winter in the ground, under loose bark and similar places of shelter. When spring opens, and the plum trees are in blossom, the adults commence to fly, and when the fruit is set to deposit their eggs. By means of her snout the female perforates the skin of the fruit, making a hole from one-sixteenth to one-tenth of an inch deep, scooped out at the bottom. In this cavity she deposits an egg and pushes it to the bottom with her snout, afterwards cutting a crescent shaped slit in front of the aperture (Fig. 16.) The number of eggs deposited by each female is from 50 to 100. The egg is of a white color, oval and oblong, about three times as long as wide As soon as the egg is hatched, which takes about a week, the larva begins at once to eat its way to the center of the fruit, where it feeds upon the pulp surrounding the stone or pit. It takes from three to five weeks for the larva to reach the point of maturity, at which time it is about two-fifths of an inch in length, and with the exception of its light brown head is of a yellowish white color. In most cases badly infested fruit does not mature but falls. When the larva has reached its full growth, it passes into the ground for several inches where it transforms into the pupal stage. It remains in this stage from three to four weeks, occasionally stopping until spring when it emerges as an adult beetle.

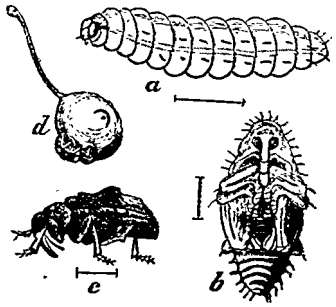


FIG. 16.
a. larva. b. pupa. c. adult.
d. plum, showing puncture and crescent.

REMEDIES

Various opinions are entertained as to best methods to be pursued in combating the attacks of the beetle. Spraying with arsenites is strongly advocated by some, while others claim the operation is attended with poor results. The beetles necessarily feed some before the eggs are deposited and during the period of depositing. Applications should be made to destroy the insects before the operation of oviposition is performed. The first treatment is best made when the leaves are just unfolding; a

second, after the blossoms have fallen, followed by a third if the attacks are severe, using Paris green at the rate one pound to two hundred gallons of water and one pound of lime. Spraying is more universally practiced at the present time than other methods. The writer has met with good results from this operation. Many adhere to the more certain method, that of jarring early in the morning while the beetles are inactive. The insects peculiarly fold up their legs beneath their bodies and fall when jarred, being caught in sheets spread on the ground. When trees are badly infested they should be jarred every morning. A mechanical contrivance is often used, constructed of heavy cloth in the form of of an inverted umbrella, open at one side to admit the tree trunk. The contrivance is placed on a wheelbarrow which is supplied with a padded punch to strike the tree. This method is quite rapid and has proved quite efficacious in many cases.

THE PLUM GOUGER.

(Coccotorus scutellaris, Lec.)

The gouger resembles the plum curculio in many respects Injuries received by it are often attributed to the latter. Its depredations are confined chiefly to regions of the Mississippi Valley and it is found in a few sections of the state. It resembles the plum curculio in many respects, being a snout beetle and appearing about the same time. The beetle (Fig. 17) is a little more than a quarter of an inch in length, of a brown color with a yellowish tinge and lacks the humps which are present on the curculio The winter is passed in the adult stage in some crevice or protected spot, appearing in the spring just before the fruit blossoms fall. When fruit is forming the beetle deposits its egg in the same manner as the plum curculio, excepting that no crescent mark is made about the point of insertion. Upon hatching, the larva burrows toward the stone or pit which it easily perforates, owing to its comparative softness, and maintains its existence by feeding upon the contents of the interior. The larvae are whitish in color with large heads. Just before entering the pupal stage, the larva cuts out a cir-

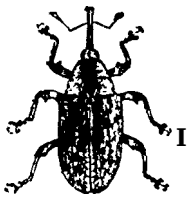


FIG 17.. Plum Gougcr.

cular hole in the natural shell through which the beetle may make its escape, usually at the close of the fruiting season, having passed the pupal stage within the plum. There is only one brood a year and it requires a much longer time to complete its transformations than does the Curculio.

REMEDIES

The plum-gouger is combated in the same manner as the plum curculio, using the same treatment.

PEACH-TREE BORER.

(Sannina exitiosa Say.)

One of the most widely distributed insects attacking peach orchards in this climate is the "peach borer." Notwithstanding the havoc noted each year, scarcely anything of its attacks, life history, or appearance is known by the majority of horticulturists of this state. Too often, peach trees planted and left to grow, suddenly weaken and die, seemingly from some unknown cause. Thus the planting of peach trees is little encouraged on the average farm. If the method of destruction of the borer mere better understood, its attacks could be more easily stopped. The damage done to the tree consists in extreme eases in the entire girdling of the tree. In slight attacks mere excavations are made in the bark and layers of the bark. Where girdling is prolonged, the infested part begins in time to decay. The eggs are deposited on the bark of the tree, ordinarily near the surface of the ground. The eggs are of a yellowish color, ova1 shaped, somewhat flattened and average about one-fiftieth of an inch in length. The earliest record of the appearance of the adult at the Station is June 16th. From about this time until fall, eggs are deposited on the bark at the base of the tree, fastened by a gummy substance which is secreted by the female. As soon as the larvae hatch, they work their way downward toward the roots. They do not perforate the bark at first but as they increase in size they gradually enlarge their channels laterally, and inwardly. When first hatched the larvae are very small but by winter some individuals attain a length of one and one-third inches (See Fig. 18.) They are of a whitish color, slightly tinged with yellow, body soft and cylindrical, slightly tapering from first three seg-

ments, head horny like, brown with strong jaws, segment next to head semi-chitinous. Fine hairs are arranged sparsely over the body, more noticeable at tip of abdomen. In studying badly infested trees at and near the college grounds during the past season, a number of important and practical observations were made. Whole trees with roots attached were removed in certain instances and studied (See Fig. 18 and 19.) Upon examination of the infested trees various stages of the larvae were found, varying in length from one-fourth of an inch to one and one-fourth inches. This variation in larvae may be found particularly in fall and spring—this fact often leads to the belief that the life history consumes more than one year; although there may seem to be several broods there is but one year employed in completing the life cycle. This difference in size is easily accounted for by the fact that eggs are deposited from about the middle of June to September. By a study of the workings of the pest, the large larvae appear to form long channels or broad, deep cavities filled with large quantities of gum and worm castings. A number of channels measured showed a measurement of one and one-fourth inches wide by two and one-eighth inches long. The larger larvae are found beneath the bark, feeding on the cambium and interior portion of the bark. Seven inches below the ground large larvae were detected which

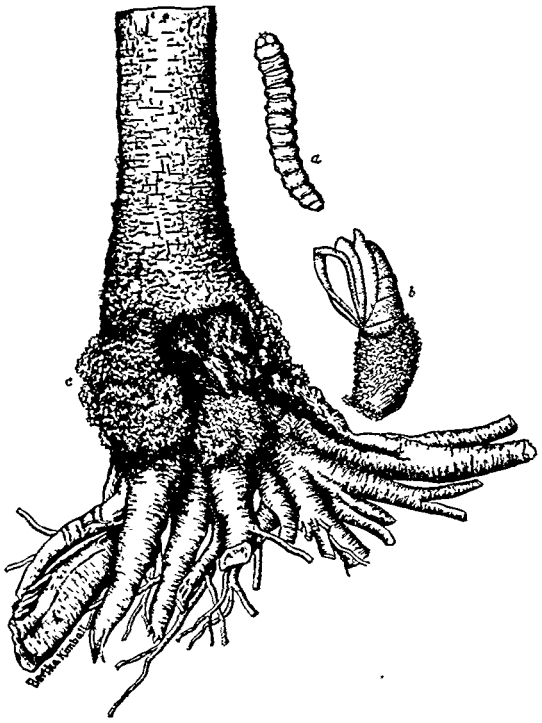


FIG. 18.
a. larva b. pupa from which adult has emerged..
c. exudation of gum. d. work of larvae on root.

had eaten one-fifth around roots, having circumference of eight inches. Several small roots next to it were dead, undoubtedly due to action of the borer. A number of trees and roots were beginning to decay, showing serious effects of the insect (Fig. 18.) In a number of instances the work of the larvae upon the roots seems more destructive than upon the trunk. They not only cut the bark and cambium but burrow grooves into the woody tissue. The larvae pass the winter in different positions as observed by careful examinations during the winter months. In a badly infested tree the liber of the bark was perforated with short channels, evidently the work of small larvae.

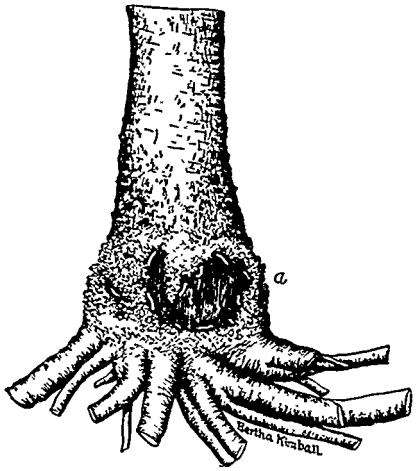


FIG. 19.
a. Larvae exposed.

Larvae were found feeding upon rotten wood, four or five inches from growing tissue, though evidently not there by accident. These larvae were in large channels about one-fourth of an inch deep. The number of larvae is dependent upon the care that is exercised in the protection of the tree. In one orchard inspected, trees were detected containing over fifty larvae. The number in other trees varied, depending upon the severity of the attack. About the middle of June the larvae have nearly all attained full size. They then spin for themselves follicles of silk with gum and excrement intermixed. The pupae (See Fig. 18) are about an inch in length, brown in color, ovate with obtusely rounded ends. They are attached to the trunk of the tree at the base just above the ground. The pupal state lasts about a month. There is a great difference in the sexes of the adults (See Fig. 20) the female being much larger and more robust than the male, from which she is easily distinguished by a broad, transverse, orange-yellow band on abdomen. Both have almost transparent wings and are of a steel-blue color.

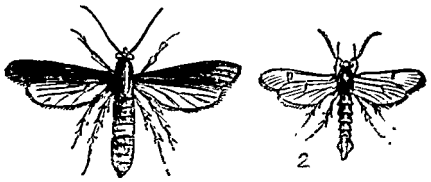


FIG. 20. Adults.

REMEDIES.

As the presence of the larvae is clearly indicated by the exudation of gum, one of the first remedies to suggest itself is to search for the larvae and remove them. The depth to which the larvae channel and the manner of their work makes the operation almost speculative, so that there is great danger of serious injury to the trees in digging for the insect, making the method almost impracticable. The best method that can be employed in combating this insect is by preventing the adult from depositing its eggs. Mounding the tree is often employed to meet this end; hilling the trees to the height of about a foot in April before the adults emerge,—thus preventing them from depositing their eggs. This mound should be left on until fall; the object as in all mechanical protections being so to protect the trunk that the adult cannot deposit its eggs nor the larvae emerge. Bands of tarred paper may be used by wrapping to a height of two feet, tying at top. These should be renewed each year. Fine wire netting which is more lasting may be employed. It should extend two or three inches below the surface of the ground. Applications of certain washes are made during the spring and summer months which are obnoxious to the moths and keep them from depositing their eggs. One of the most common used is an alkaline wash, consisting of soft soap and washing soda made to the consistency of paint, to which enough crude carbolic acid is added to give the mixture a strong odor. Apply the wash with a stiff brush at various times during the season.

THE FLAT-HEADED BORER.

(Chrysbothris femorata, Fabr.)

The work of the "flat-headed borer" is well known in the state. This insect selects for its attack principally trees which are weakened, owing to poor soil, lack of cultivation, prolonged drouths and unusual extremes of cold and heat.

The insect almost invariably attacks only unhealthy trees, and selects as a place for the depositing of its eggs sun-scalded parts of the tree or parts that have been injured or bruised.

The apple, pear, plum, peach, cherry, quince and ash are subject to attack. That the tree is being attacked is indicated usually by a discoloration of the bark on the south and southwest sides where the larvae may be found in the largest numbers. Upon

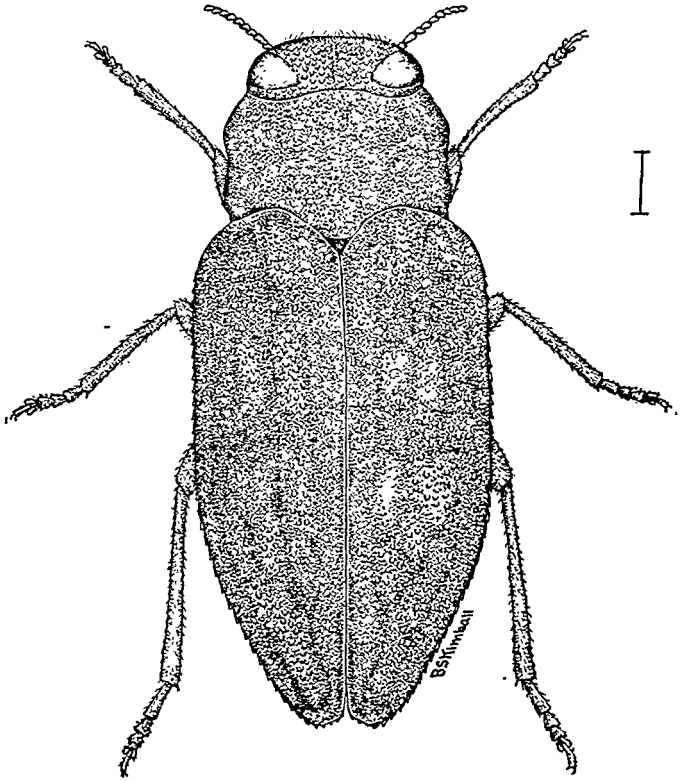


FIG 21. Adult.

removing the bark numerous channels may be found upon the inner sap wood, which are filled with the castings of the larvae. These channels often girdle the tree. The adult (Fig. 21) is flat and depressed, about three-eighths of an inch in length, general color greenish black with copper reflections.

The insects appear in this latitude about the last of May; eggs are deposited from that time on until September. The adult is a lover of sunshine and may be often found basking in the rays of sunlight or running to and fro with remarkable activity upon the tree. In the early morning and evening or during stormy weather the insect is more sluggish in its move-

ments. The eggs are small and yellowish in color, irregularly ribbed and are deposited either singly or in numbers in the crevices of bark afforded on trunks of trees between the ground and lower limbs, being attached by means of a gummy substance secreted by the female. Upon hatching, the larva (See Fig. 22.) yellowish in color with a broad, flattened head, gradually makes its way to the sap wood upon which it feeds during the early stages of life. It is at this period that the presence of the larvae is noted by the exudation of "worm castings." As they develop in size and strength they devour more ravenously the hard wood, boring flattened channels. The time required for the larvae to reach maturity is not known, but it is generally agreed that they take but one year to complete their transformations. When the larvae have obtained their full growth they gnaw a channel to the outside, cutting through the bark with the exception of a thin partition, and then retreating a little way they block their channel with castings, and change to chrysalides.

FIG. 22. Larva.

REMEDIES.

All the trees should be kept in a healthy condition. By this means most trees may be kept exempt from attacks.

Infested trees should be stimulated to make vigorous growth, —thus increasing the flow of sap which is injurious to the young larvae, usually causing death by drowning. Unthrifty trees in the orchard should be brought into a state of thrift, by training trees, avoiding careless pruning, and preventing sunscalded and decaying spots. In fact, the orchard should be made as exempt as possible from the infestation of the pest. The orchard should be inspected during the autumn, and wherever the work of the borer is detected by discoloration of the bark or by saw dust filings the larvae should be dug out with a knife. As a mechanical preventive the trunks and large limbs of trees should be given a coat of alkaline wash recommended for the "peach-tree borer" which is repulsive to the female during oviposition. This application should be made during May and repeated at intervals during the summer.

ROUND-HEADED APPLE-TREE BORER.

(Saperda candida Fabr.)

The round-headed apple-tree borer is readily distinguished from the flat-headed apple-tree borer in its appearance and life history, though attacking the same trees when under same conditions. The adult is a little over five-eighths of an inch long (See Fig. 23) having long jointed feelers or antennae, extending over the back. It is brown above, with two white stripes extending dawn the

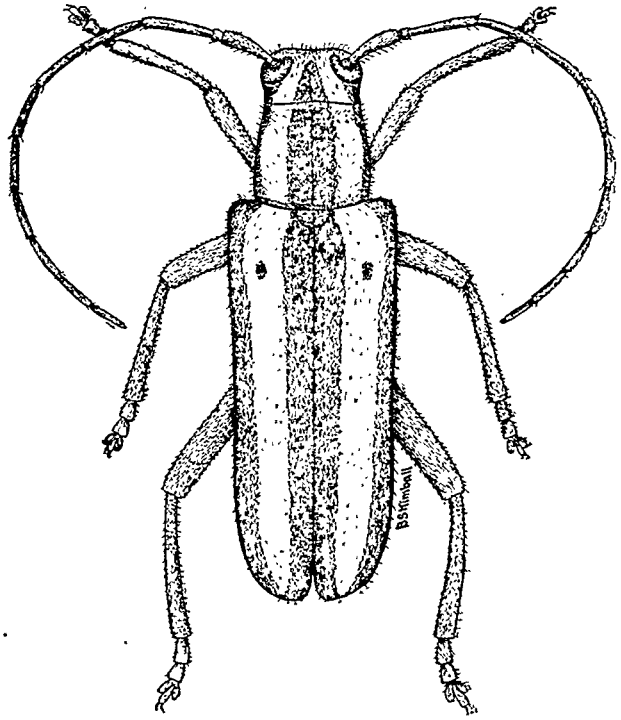


FIG 23. Adult. (greatly enlarged)

back, the head and under surface of the body grayish. The insect is nocturnal; during the day it remains concealed but at dusk commences to fly and to deposit its eggs. The female appears about the first of June and stays until September. Eggs are deposited in small incisions in the bark of the trunk near the ground and occasionally on some of the lower, larger limbs. In about two weeks the

larvae hatch and commence to gnaw their way into the inner bark and sap wood, where they burrow out disk shaped cavities, leaving

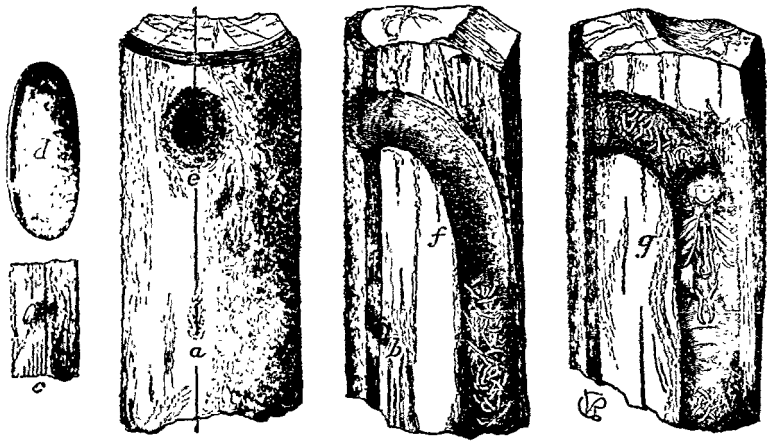


FIG. 24.

a Incision in which egg is deposited. b. same, the wood has been split along line a, c, showing egg in place. c. showing how egg is inserted under bark. d. egg greatly magnified. e. hole through which adult emerged. f channel of larva. g. insect in pupal state just before issuing as an adult.

excavations behind them filled with their castings (Fig. 24.) The young larvae confine their attacks for the first two summers to the sap wood where they accomplish their greatest damage. If a number are working in close proximity on a young tree the chances are that it will be girdled. After the second winter the larvae are more active and make rapid growth. As they approach maturity they cut cylindrical channels upward in the hard wood of the tree; by fall they have attained full size. They then burrow outward to the inner surface of bark and there in the cavity thus made and lined with castings and woody fibre they remain inactive until spring when they pass into the pupal state. In about three weeks the transformation is completed; the adults having worked their way through the barriers of castings gnaw a hole through the bark and escape. The larvae (Fig. 25) when

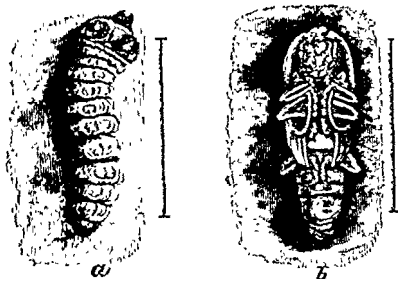


FIG 25. Larva and pupa.

full grown are over an inch in length, whitish in color, footless and fleshy, with a brown head.

REMEDIES.

The same treatment should be given for the destruction of this insect as for the Flat Headed Borer.

THE SAN JOSE SCALE.

(Aspidiotus perniciosus, Comstock.)

Owing to the seriousness of its attacks, unquestionably this scale is the worst pest known to the orchards of this continent. Owing to a lack of information or to indifference many do not consider the importance of its attacks, but those who have had actual experience know too well the immense damage it may do, the

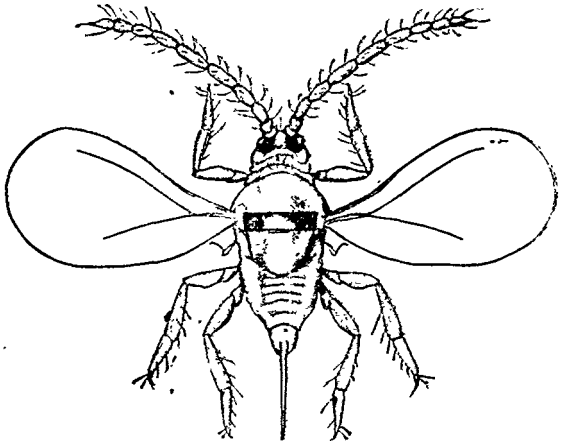


FIG. 26. San Jose Scale. Male adult, greatly enlarged. (Howard & Marlatt Bulletin 3. New Series, Div. of Ent, U. S Dept. of Ag.)

difficulty of its extermination and of the need of immediate action upon its first appearance. Thus far no evidence of its presence in Kansas has been detected. The rapid spread of the San Jose Scale during the past few years in this country has given cause for serious alarm. Its presence in an adjoining state and its seeming adaptability to a large range of climates places this state in imminent danger. If detected, active steps should at once be taken for its eradication. On account of its minuteness, its unfamiliar form, its omniverous character and its wonderful powers

of reproduction it is the dreaded foe of the orchard. Added to this is the easy means of introduction through the purchase of nursery stock from nurseries in close proximity to infested districts.

The name San Jose comes from the district of San Jose Valley, California, where its ravages in this country were first

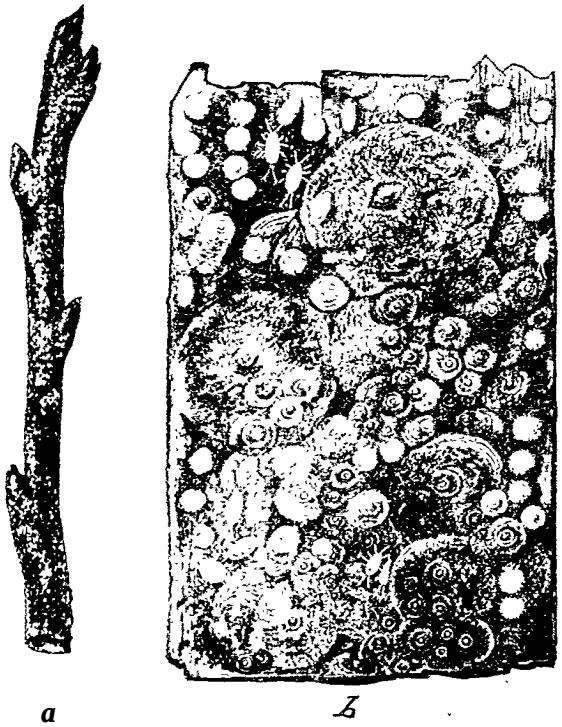


FIG. 27. San Jose scale on bark. a. infested twig. b. bark of same, greatly magnified, showing various developments of San Jose Scale. (Howard and Marlatt, Bull. 3, New Series Div. of Ent., U. S Dept. of Ag.)

detected about the year 1873, since which time it has spread into Missouri, Illinois, Ohio, Maryland, New Jersey, Pennsylvania, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Alabama, Florida, Massachusetts, Delaware, Mississippi, Michigan, Ontario, British Columbia, Canada, Oregon, Texas, Idaho, Washington and New Mexico.

It attacks a large number of fruit and garden trees and shrubs. Apple, pear, peach, plum, cherry, grape, apricot, raspberry, gooseberry, elm and osage orange are those particularly to be mentioned. The bark of trees when badly affected with this pest

loses its natural, vigorous, healthy appearance and takes on a rough, gray, scurfy deposit. (See Fig. 27.) This deposit consists of a large number of nearly circular scales, composed of secretitious material and moulted skins. There are a number of this class of insects more or less destructive in their habits. To determine one from another is the work of a specialist. There are, however, some general characteristics of the San Jose Scale which may be detected by the naked eye or by the aid of an ordinary hand lens. It is circular in form, very minute, not more than one-sixteenth of an inch in diameter, slightly convex, with a black or yellowish point at the center. Beneath this scale lives the real insect, the author of all the injury. The young scale as soon as it is born, crawls from under the female scale, and after inspecting its surroundings for a few hours inserts its beak into the tissue of the plant. Here it remains until it dies. In about three days the insect is enveloped by a scale covering. By winter the scale is about half grown, and as soon as the warm weather sets in the insect commences to feed and to develop, reaching maturity about the middle of May. From this time on the young begin to emerge, and continue emerging until the arrival of cold weather, making a number of generations during the season,—probably four or five. During a season, as estimated by Howard and Marlatt, Bulletin No. 3, U. S. Department of Agriculture, Division of Entomology, a single female may reproduce 1,608,040,200 individuals.

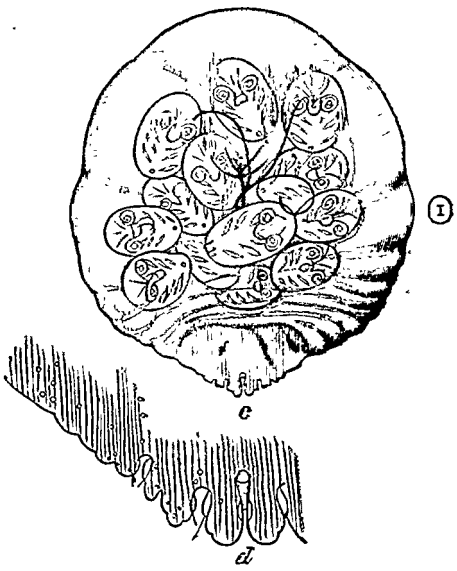


FIG. 28. Under-side of San Jose Scale. c. Adult female containing young, greatly enlarged. d. Anal fringe of same enlarged. (Howard and Marlatt, Bull. 3. New Series, Div. of Ent', U..S. Dept. of Ag.)

WHAT TO DO.

As soon as scale specimens of any nature are discovered they should be sent at once to this department for identification. The

worst danger is from importation on nursery stock. It has become customary during the last few years to have certificates from entomologists accompanying orders from nurseries, where stock was liable to be infested, showing the nurseries to be free from scale. Too much reliance should not be placed in these certificates. The giving of certificates has been abused in many instances by nursery men to cover all stock shipped, whether from nursery inspected or from other nurseries. Then again it seems absurd that a nursery of thousands of trees could be thoroughly inspected by one man. In some states certificates are not given, relying upon the personal examination by the buyer upon receiving stock. This is perhaps the most satisfactory.

pest are whale oil soap and water, at the rate of two pounds of soap to one gallon of water, used as a winter wash, followed by a spray of strong kerosene emulsion at intervals through the summer. In as much as experiments are being carried on in infested districts to devise more satisfactory remedies than the above, it seems best to postpone further discussion until the insect makes its appearance in the state when the latest information will be given to the public. Those desiring further information regarding the San Jose Scale should apply to Div. of Entomology, Dept. of Ag., Washington, for Bulletin No. 3, New Series.

THE ELM-TWIG GIRDLER.*

(Oncideres cingulatus Say.)

For the past few years this insect has been committing such extensive depredations upon the elms of this state that it seems essential that some information be given regarding its habits, and the means for combating it. It need not, and perhaps never will be, a serious or formidable pest if advantage is taken of the simple remedy which, because of the peculiar habit of the insect, readily suggests itself. The injury done by this insect consists in the girdling and cutting of small branches so that sooner or later they are brought to the ground by the wind. By the excessive pruning they often receive the elms become scraggy and unsymmetrical, and their beauty is marred by the number of half-severed twigs with their dried leaves which sway to and fro till severed by the wind.

ITS INJURIES NOT CONFINED TO ELMS.

Although the girdler shows a decided preference for elms it has been observed to attack other trees, particularly persimmon, oak, locust and cherry,—the last three, however, were in close proximity to elms. In other states the insect has a wider range; in Mississippi it is commonly found on hickory, pecan and persimmon trees; in Pennsylvania it attacks the hickory, while in Illinois it was frequently found girdling the pear, hickory and persimmon. Besides these there are others which should be mentioned, principally the linden, apple, peach and plum. It is important to note the last three, for if it should cultivate a taste for fruit trees in this state as it has done in others it may prove as serious a pest to the orchardist as the apple-tree pruner which like the girdler can easily be controlled, but unfortunately has been allowed full sway to carry on its destructive work.

EGG.

The egg is of a white color, elongated oval in shape, with ends obtusely rounded, indented with slight longitudinal depressions, and about one-eleventh of an inch long by about one-fourth as wide. Eggs are deposited at the base of an offshoot or bud, generally parallel with longitudinal axis of branch, and beneath the bark or in the layers of bark, usually but one egg to each shoot. (Fig. 29.) Often two eggs and sometimes four or five are deposited, and in a number of instances eggs were deposited at the side of and above the offshoot. The number of eggs deposited on one

*The investigation of the Oncideres cingulatus comprises the original work of Pereival J. Parrott of this department.

branch is not constant, varying from one to a dozen, and even higher. Besides being laid on main stems eggs are often deposited on offshoots.

The time that it takes for an egg to hatch is dependent upon the season of the year in which the egg is deposited. Eggs laid in August hatch in less time than those deposited in October. In the laboratory they will hatch in about three or four weeks. Frequently the larvae did not all hatch out at the same time; thus different degrees of development often appear in the same branch. For instance, in one branch that fell Sept. 19th there were on Dec. 3rd a number of larvae, and several eggs, unhatched, but containing live larvae, both of which undoubtedly would pass the winter in their respective stages. The eggs hatch with the head of the larvae nearest the base of the offshoot.

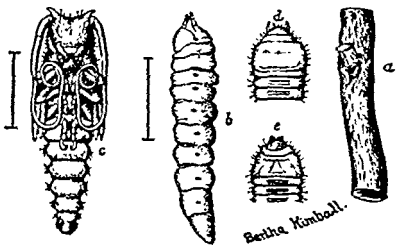


FIG 29 a. Egg deposited at base of offshoot b. larva. c. pupa. d, e. Showing markings on upper and lower side of larva.

LARVA.

When newly hatched the larva is a soft, fleshy apodous grub, slightly covered with light colored hairs. It is somewhat shining and of a white color, with its mouth parts slightly tinged with brown. When just emerged from egg it is about one-tenth of an inch in length and just before pupation it reaches its maximum length of about three-quarters of an inch. It is divided into twelve rings by deep, transverse grooves. It is nearly cylindrical in form, tapering a little behind and swollen at the anterior extremity, with a smallhead which is retractile within the large anterior corneous segment. In the full grown larva the mandibles are light brown at base, shading to almost piceous at tip. The remaining mouth-parts are yellowish, concolorous with rest of head, except small, brownish colored notches on the lateral anterior portion of the epicranium, and a brown, sub-ventral line which runs from base of each mandible to anterior edge of first segment. On the upper and subdorsal portion of the epicranium, near anterior margin, is a row of short, parallel, chitinous ridges, interrupted at the middle by the dorsal suture. Upon the dorsal surface of each segment of the mature larva, commencing with the third and ending with the tenth, and on the ventral side of each segment, commencing with the second and ending with the tenth, appears a slight swelling containing a double, transverse row of tooth-like projections, from twelve to eighteen in number,—sometimes with a few odd ones in front of each row. (Fig. 29.)

For the most part the eggs are all hatched by fall, though a a number of larvae pass the winter within the egg. During the winter months the larvae make but little growth, remaining in a

dormant condition within the fallen branch. As the warm days of spring approach they commence to eat and to make rapid growth. The moisture of the winter months has reduced the twigs to just the condition that the larvae desire, as is shown by the voraciousness with which they dispose of them. From the spot where the egg is laid, the larva, as soon as weather is suitable, gnaws its way downward beneath the bark, gradually lengthening and broadening its channel. (Fig. 30.) In twigs with a diameter of nearly one-half of an inch one larva will often make a channel two inches long, disposing of nearly one-half of the wood within that space but always leaving the bark intact. In instances where the eggs are deposited at the base of all the offshoots (which in the elm branch alternately) and when offshoots on the same side are close together, the larvae will leave scarcely anything of the twig,—nothing but a shell of bark, and thin, irregular, uneven, but never perforated partitions. (Fig. 31.) In such instances as this, two successive offshoots on the same side are often the termini for one channel. In the larger twigs this is not so noticeable, as the diameter of the twig is larger, and two successive offshoots are farther removed, giving more space than one larva can consume.

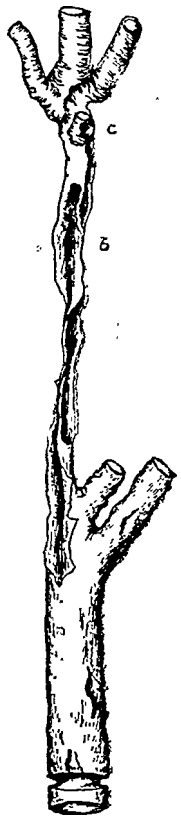


FIG. 30.
a, girdling of twig.
b, c. channels of larvae.

When eggs are deposited on the lateral offshoots of the girdled branch the average length of the channels is much longer, owing to the smaller circumference of the twig, which in many instances scarcely exceeds that of the larvae. In all cases of this kind that came under the notice of the writer there happened to be only one larva present, although there were clear indications that other larvae had hatched in the same offshoot. In the offshoots and twigs with a diameter of three-sixteenths of an inch or less, one larva will often consume the interior wood for the entire length of its channel, so that it is impossible to pick up the twig without its breaking to pieces.

When larvae are nearly full grown a peculiar clicking sound, together with the vibration of the dry bark, is often noticed. This is produced by the rapid swaying of the anterior portion of their

bodies from one side to the other, at the same time catching the points of their mandibles in the fibres of the wood. At this time the larvae are busy blocking up with small shavings the ends of their channels, and all holes and cracks in the bark. About the middle of July they pass to one end of their channel, and there in the midst of short, woody fibres pass into the pupal state.

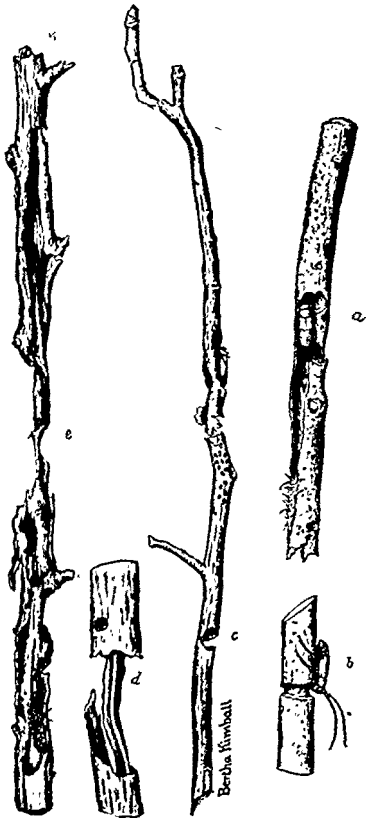


FIG 31 a. bark removed showing ing adult just emerged from pupa b. adult girdling. c. hole, through which adult has emerged. d, e, bark removed showing work of larvae

PUPA.

The pupa is of a yellowish white color, and about three-quarters of an inch in length. The antenna1 sheaths arise from the notch on the inner,upper half of the eyes, and crossing them, pass down along each side of the back, over the wing sheaths and just above the sheaths of first and second pairs of legs,—and then turning inward, pass back toward the mouth-parts, where they turn outward, forming a circle over the sheaths of first pair of legs. The first and second pairs of legs are above, and the third pair with exception of tarsi are below the wing sheaths. On the inner and upper margin of the base of the antenna1 sheaths is a short, slightly-curved, horn-like protuberance, pointing backward and outward (Fig. 29.) Small. brownish, sharp points occur on the following parts of abdomen: the swellings which appear on the side of each abdominal segment with exception of the first, the upper surface, and posterior margin of anal segment, which is thickly fringed with sharp, excurved points.

The pupae do not remain in one position but change from one part of their channel to another. When touched in some instances they would simply turn over and over, while at other times by thrusting the spiny tip of their abdomen against the sides of their channel they would force themselves revolving to one end.

The pupal state lasts about two weeks, and out of thirty-eight instances twenty-seven issued as adults within the period between July the 18th and August the 3d.

ADULT.

The adult when just emerged from its pupal skin is of a yellowish color, but gradually darkens till about the third day when it assumes its normal color (Fig. 32.) It does not immediately pass out of the channel, but spends several days eating, and gnawing a hole in the bark through which to make its escape. (Fig. 31.)

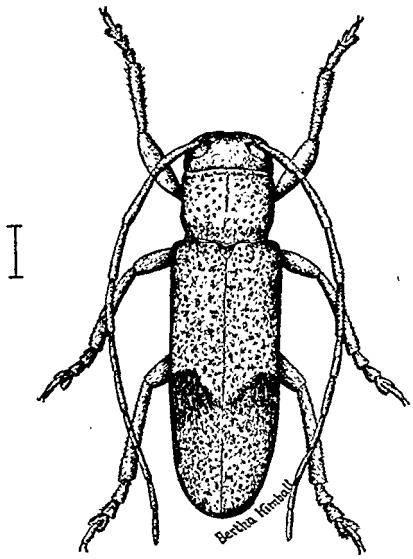


FIG. 32. Oncideres cingulatus. (Adult.)

It is sub-cylindrical in shape, "body robust, covered with short, prostrate hairs: head varied with fulvous, a slender, fulvous line around the eye, a frontal indented line: antennae much longer than the body, but not twice as long: thorax obviously broader than long, slightly varied with fulvous: elytra with numerous obsolete small, fulvous dots; at base and tip broadly reddish brown: a broad cinereous, somewhat undulated band on the middle." (Say.)

The adults vary from seven to nine-sixteenths of an inch in length.

The beetle having emerged from its channel spends some time in feeding or resting upon the outside of the twig and then flies to an overhanging tree. The girdling of the twig is done entirely by the female, and one has only to pick up one of the fallen twigs to see the nicety of her work. The male does little else beside resting, or feeding upon the tender offshoots which he often severs, and occasionally making a visit to his mate who is either girdling the twig or depositing eggs. Having alighted on a twig with a diameter seldom more than one-half an inch she commences to work (Fig. 31). She does not make a complete circle at once, but cuts section by section as if cutting as deep as the edges of the groove will permit her. Having cut one section she reverses her position and rubs the proximal edge of the groove with her ovipositor, whether to remove the chips, or not, I could not determine. After several seconds she would either resume her old position or would pass up the branch to deposit an egg. Upon returning to work she would take another section, cutting in the same manner as in the first. After cutting a section or two she would again smooth

off the edge with her ovipositor, and then deposit another egg, or in some cases would go over her work as if to deepen it.

The time that it takes to cut a twig varies with the width and depth of groove, the circumference of the twig and the number of eggs deposited; for the eggs are not all deposited in succession, but are laid during and after the process of cutting. In some instances twigs fall in which no eggs are present, but this seldom occurs. Of two twigs that were watched with particular care one took twelve hours to cut and upon this six eggs were deposited, while the other took fifteen, with only five eggs deposited: but the latter had a greater diameter than the former.

There has been some doubt as to the position of the girdler when cutting, some maintaining that she does her cutting while resting on the stub, while others that she cuts on the other side of the groove. She invariably cuts with her head downwards, regardless of the slant of the twig, whether upwards or downwards. Several simple experiments proved this. A number of twigs were placed in an upright position while others were reversed, and with scarcely an exception she cut as stated. Sometimes on the under-side of a slanting twig she changed her position for a few seconds.

In depositing her eggs the girdler first makes a hole just below an offshoot or an aborted bud of the main stem. Within and below the hole, and generally parallel to the longitudinal axis of the branch she places her egg, so as to lie concealed beneath the bark or in the layers of bark, afterwards sealing the hole with a brownish, gummy substance for disguising and protecting the work she has done. The time that it takes to deposit an egg, including the cutting and sealing of the hole, is from ten to twelve minutes. The total number of eggs that might be deposited, and the number of twigs that might be girdled by one female, the writer was not able to determine conclusively. One female after being taken into the laboratory girdled three twigs, which with the one on which she was collected, would make four to her credit. Upon these branches twenty-five eggs were deposited.

PREVENTIVES.

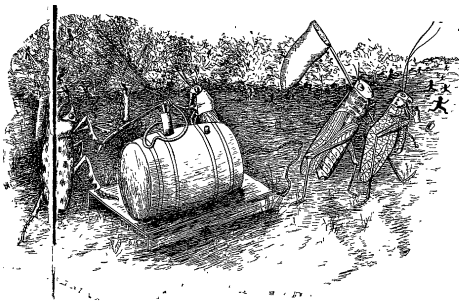
All that is required to combat this insect is to gather the fallen branches and burn them: for, as is readily seen, in doing this, all eggs and larvae will be destroyed, which would otherwise develop into beetles by the following summer. To obtain any permanent results it is necessary that all should make it a practice to burn

the fallen twigs. The chances are that in doing this, other injurious insects will also be destroyed. In Fig. 30., we have an excellent illustration of this. This twig which had been girdled, and in which eggs had been deposited by the Oncideres cingulatus, also contained working in the interior a larva of the twig pruner which had passed through and just below the point girdled, and had so severed the twig that the first high wind caused the twig to break not where it was girdled but at the point severed by the pruner, so that the fallen twig contained the larva of the twig pruner and a number of eggs of the Oncideres cingulatus. Owing to unfavorable circumstances a large number of larvae never reach maturity. This is particularly noticeable along the creeks and ravines where in a rise of water the fallen twigs from overhanging branches are often buried in debris and mud, or carried to some angle of the stream where they are collected with other refuse; the last may often be the means for the further dissemination of the insect. Where moisture is too prolonged as in parts of twigs buried beneath accumulations of dead grass and leaves the larvae will often succumb. The larvae seem to prefer enough moisture to cause the twig to decay without its being water-soaked.

Acknowledgements are due Wm. Barnes, Secretary Kansas State Horticultural Society for loan of cuts, Fig. 11, 17, 20, 22, 24, 25.

The bulletins and annual reports of this Station will be sent-free to residents of Kansas, on application to the Secretary of the Experiment Station. Manhattan, Kansas.
Publishedby order of the Council I. D. GRAHAM, Secretary.

KANSAS STATE EXPERIMENT



SPRAY CALENDAR

Manhattan, March 1898, Bulletin 77.

E. H. FAVILLE. P. J. PARROTT.

PLANT.	PEST.	REMEDY.	1st APPLICATION.	2nd APPLICATION.	3rd APPLICATION.
APPLE	Apple-tree tent-caterpillar	Paris green	Before buds open	Two weeks later	Paris green when caterpillars appear.
	Apple-tree aphis	Alkaline wash (1) Kerosene emulsion (2)	In early spring (1)	At opening of buds (2)	Two weeks later (2)
	Bitter rot	Bordeaux mixture	Before leaves expand	After fruit has set	Two weeks later
	Canker-worm	Paris green	When caterpillars first appear.	One week later	One week later
	Codling moth	Paris green*	Just after blossoms fall	A week later	
	Scab	Bordeaux mixture	When buds are swelling	Just before buds open	Ten days later
CHERRY	Cherry-leaf aphis	Alkaline wash (1) Kerosene emulsion (2)	Before buds open (1)	When aphids appear (2)	
	Curculio	Paris green in Bordeaux	When buds are opening	When fruit is set	One week later
	Leaf spot	Bordeaux mixture	Before buds open	Two weeks later	Two weeks later.
	Rot	Bordeaux mixture	Before flower buds open	When fruit is set	Ten days later
CURRANT	Currant worm	Paris green in Bordeaux (1) Hellebore (2)	Before flower buds open (1)	One week later (2)	Hellebore when worms are present
	Leaf spot	Ammoniacal carbonate of copper (1) Bordeaux mixture (2)	Middle of June (1)	After fruit is removed (2)	Ten days later (2)
GOOSEBERRY	Worm	Paris green in Bordeaux (1) Hellebore (2)	Before leaves expand (1)	One week later (2)	When worms appear (2)
GRAPE	Anthracnose	Copper sulphate (1) Bordeaux mixture (2)	Before buds start (1)	When leaves are half size 2	When fruit has set (2)
	Leaf-hopper	Kerosene emulsion	When first seen	A week later	
	Black and brown rot	Copper sulphate (1) Bordeaux mixture (2)	Before buds start (1)	Just before blossoming (2)	When fruit is set (2)
PEACH	Aphis	Alkaline wash (1) Kerosene emulsion (2)	Before buds open (1)	Two weeks later (2)	
	Codling moth	Paris green	Just after blossoms fall	One week later	
	Curculio	Paris green in Bordeaux	When buds are opening	When fruit is forming	One week later
	Leaf-curl	Copper sulphate (1) Bordeaux mixture (2)	Just before buds swell (1)	Just before blossoms open 2	After blossoms fall (2)
	Rot	Bordeaux mixture	As buds are swelling	Just after blossoming	After fruit is set
PLUM	Curculio	Paris green in Bordeaux	Before buds open	When fruit is set	One week later
	Rot	Bordeaux mixture	As buds are swelling	Just after blossoming	After fruit is set
RASPBERRY BLACKBERRY	Anthracnose	Copper sulphate (1) Bordeaux mixture (2)	Before buds start (1)	Ten days later (2)	After old canes are cut out (2)
	Rust	Same as anthracnose			
STRAWBERRY	Leaf blight	Bordeaux mixture	When growth first starts	At opening of earliest blossoms	After crop is off remove old foliage, and burn it Spray every three or four weeks.
	Leaf roller	Paris green	By first of May	Three weeks later	In July, mow the plants and rake off leaves, and destroy
BEET	Scab	Avoid infected soil			
CABBAGE	Worm	Paris green and flour (1) Pyrethrum (2)	When worms first appear 1	Week later (2)	Repeat 2d when worms appear
ONION	Thrip	Kerosene emulsion	At first appearance	Every 3 or 4 days till pest is gone	
POTATO	Potato scab	Soak uncut seed potatoes	for 1½ hrs. in solution of 1	oz. of corrosive sublimate	to 15 gallons of water or
	Potato rot	Bordeaux mixture	By first of July	Two weeks later	Two weeks later
	Colorado beetle	Paris green	When worms first appear	A week later	Use Paris
	Blight	Bordeaux mixture	Last of May for early potatoes	Two weeks later	Two weeks later

INSECTS TREATED BY OTHER MEASURES.

APPLE	Apple-root plant louse	Remove earth from base of tree, and pour in water, heated not to exceed 150 degrees Fahr.
	Apple-tree tent-caterpillar	Remove nests from trees by a forked stick or gloved hand.
	Apple twig pruner	Gather and destroy fallen twigs.
	Canker-worms	Prevent ascent of female moths by traps or obstructions.
	Curculio	Jar trees so that adults fall on a sheet where they may be collected and destroyed.
	Leaf-crumpler	Collect and destroy leaf masses.
PEACH PLUM	Tree-borers	Apply alkaline wash or one gal. of whale oil soap-suds to an ounce of carbolic acid to trunk of tree, remove larvae with a knife.
	Peach-tree borer	Apply alkaline wash, or one gal. of whale oil soap-suds to an ounce of carbolic acid to trunk of tree, mound trees in spring, remove worms by knife in fall and spring.
	Curculio	Jar trees so that adults fall on a sheet where they may be destroyed.
SQUASH CABBAGE	Gouger	Same as for Curculio.
	Bug	Destroy vines as soon as crop is gathered; collect eggs and adults, and destroy.
	Aphis	As soon as aphids appear on cabbages, spray with kerosene emulsion.
	Harlequin-bug	Plant mustard between cabbages which attracts the bugs, then spray mustard with kerosene.

INSECTICIDES.

KEROSENE EMULSION.

Kerosene	2 gals.
Water (rain)	1 gal.
Soap	½ lb.

The soap should be thoroughly dissolved in boiling water. Then add kerosene while emulsion is warm, and violently agitate till it reaches a creamy consistency. For use this should be diluted: one part of emulsion to 15 parts of water. This is good for plant lice or scale insects, and for all insects with sucking mouth parts.

PARIS GREEN.

WET.

Paris green 1 lb.
Water 150 to 200 gals.

Better results are obtained by adding one pound of lime to the above if used on trees sprayed repeatedly.

DRY.

Paris green 1 lb. to 50 lbs. of flour or plaster of Paris.

London purple can be used instead of Paris green.

PYRETHRUM.

Mix with three or four times its weight of flour, and keep in a closed can 24 hours before using.

HELLEBORE.

When used dry it should be mixed with two or three times its weight of road dust or cheap flour. FOR WET MIXTURE, one ounce to two or three quarts of water.

BORDEAUX MIXT

Copper sulphate
Quick lime

First dissolve the copp
This can be done by hot
pending the sulphate wit
a bucket of water. The li
slaked in another vessel,
should be strained throug
ing. Pour both togethe
water to make 50 gallons
roughly. As a combined
is often advisable to add

REPELLANT FOR

Soap suds (whale oil soa
Carbolic acid (crude)

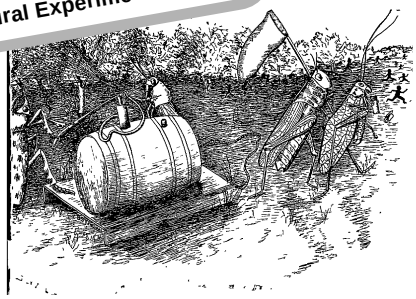
COPPER SULPHATE

Copper sulphate
Water

Hot water enough to d
sulphate.
Use only when trees a

Aim to have pumps w
Copper sulphate solu
*For Codling moth p
If trees with tender l
copper sulphate
Newspaper remedies
Stir solutions thoro

EXPERIMENT STATION.



SPRAY CALENDAR.

anhattan, March 1898, Bulletin 77.

P. J. PARROTT. W. L. HALL.

	1st APPLICATION.	2nd APPLICATION.	3rd APPLICATION.	4th APPLICATION.	5th APPLICATION.
.....	Before buds open.....	Two weeks later..	Paris green when caterpillars appear.		
)	In early spring (1).....	At opening of buds (2)....	Two weeks later (2).....		
.....	Before leaves expand.....	After fruit has set.....	Two weeks later.....	month later.....	
.....	When caterpillars first appear.	One week later.....	One week later.....		
.....	Just after blossoms fall...	A week later.....			
.....	When buds are swelling ..	Just before buds open.....	Ten days later.....	Same as 3rd.....	Same as 3rd.....
)	Before buds open (1).....	When aphids appear (2)..			
aux..	When buds are opening...	When fruit is set.....	One week later.....		
.....	Before buds open.....	Two weeks later.....	Two weeks later.	Two weeks later.....	Two weeks later.....
.....	Before flower buds open...	When fruit is set	Ten days later.....		
ux(1)	Before flower buds open(1)	One week later (2).....	Hellebore when worms are present	Same as 3rd....	Same as 3rd.....
f cop-	Middle of June (1).....	After fruit is removed (2).	Ten days later (2).....		
ux(1)	Before leaves expand (1).	One week later (2).....	When worms appear (2)..		
.....					
.....	Before buds start (1).....	When leaves are half size 2	When fruit has set (2)....	Two weeks later (2).....	In two weeks use ammoniacal copper carbonate.
.....	When first seen.	A week later.....			
.....	Before buds start (1).....	Just before blossoming (2)	When fruit is set (2)	Ten days later (2)	Ten days later ammoniacal copper carbonate
.....	Before buds open (1).....	Two weeks later (2).....			
.....	Just after blossoms fall ..	One week later.....			
aux..	When buds are opening ..	When fruit is forming	One week later.....		
.....	Just before buds swell (1)	Just before blossoms open 2	After blossoms fall (2)	After fruit is set (2).....	
.....	As buds are swelling	Just after blossoming.....	After fruit is set	Ten days later.....	As fruit is coloring.....
leaux	Before buds open.....	When fruit is set.....	One week later		
.....	As buds are swelling.....	Just after blossoming. ...	After fruit is set.....	Ten days later.....	Ammoniacal copper carbonate as fruit is coloring
.....	Before buds start (1).....	Ten days later (2).....	After old canes are cut out (2)		
.....	When growth first starts..	At opening of earliest blossoms	After crop is off remove old foliage, and burn it Spray every three or four weeks.		
.....	By first of May.....	Three weeks later.....	In July, mow the plants and rake off leaves, and destroy		
(1)	When worms first appear 1	Week later (2).....	Repeat 2d when worms appear	Same as 3rd	Same as 3rd .....
.....	At first appearance	Every 3 or 4 days till pest is gone			
toes	for 1½ hrs. in solution of 1	oz. of corrosive sublimate	to 15 gallons of water or..	cover seed with sulphur...	before planting.....
....	By first of July.....	Two weeks later	Two weeks later.....		
....	When worms first appear .	A week later.....	Use Paris.....	green for	potato beetle.....
.....	Last of May for early potatoes	Two weeks later..... ..	Two weeks later.....		

) BY OTHER MEASURES.

ase of tree, and pour in water, heated not to exceed 150 de-

ees by a forked stick or gloved hand.
allen twigs.
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PARIS GREEN.

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London purple can be used instead of Paris green.

PYRETHRUM.

eight of flour, and keep in a closed can 24 hours before using.

HELLEBORE.

ixed with two or three times its weight of road dust or n, one ounce to two or three quarts of water.

FUNGICIDES.

BORDEAUX MIXTURE.

Copper sulphate	4 lbs.
Quick lime	4 lbs.

First dissolve the copper sulphate. This can be done by hot water, or suspending the sulphate within a sack in a bucket of water. The lime should be slaked in another vessel, and if lumpy should be strained through coarse sacking. Pour both together, add enough water to make 50 gallons and stir thoroughly. As a combined insecticide it is often advisable to add Paris green.

REPELLANT FOR TREES.

Soap suds (whale oil soap)	1 gal.
Carbolic acid (crude)	1 oz.

COPPER SULPHATE SOLUTION.

Copper sulphate	1 lb.
Water	25 gal.

Hot water enough to dissolve copper sulphate.
Use only when trees are dormant.

AMMONIACAL CARBONATE OF COPPER.

Carbonate of copper	5 ozs.
Ammonia	2 qts.
Water	40 or 50 gals.

The carbonate of copper should be dissolved in the ammonia, and the solution kept tightly corked till use, when it should be mixed with 40 or 50 gallons of water. To be used when Bordeaux mixture stains fruit.

ALKALINE WASH.

Dissolve washing soda in water till no more will dissolve, then add to soft soap till it forms the consistency of thick paint.
Enough carbolic acid should be added to give a strong odor.
This should be applied to bark of trees from the base up to the main branches.

NOTES.

Aim to have pumps with working parts of brass.
Copper sulphate solution to be used only before buds open.
*For Codling moth put ½ Paris green in Bordeaux mixture.
If trees with tender leaves are injured by above Bordeaux mixture, reduce copper sulphate one-half and add more lime.
Newspaper remedies are not always to be relied on.
Stir solutions thoroughly while spraying.