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COLLEGE OF AGRICULTURE AND MECHANIC ARTS,

Agricultural Experiment Station

BULLETIN NO. 54.

THE STRAWBERRY FALSE-WORM.

THE STRAWBERRY LEAF-ROLLER.

COLUMBIA, MISSOURI.

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Two Insects Injurious to the Strawberry.

I. The Strawberry False-Worm.

Harpiphorus maculatus, Nort.

II. The Common Strawberry Leaf-Roller.

Phoxopterus comptana, Frohl.

By J. M. STEDMAN, Entomologist.

SUMMARY OF RESULTS.

From the observations and experiments conducted by this station during the past two years on insects infesting the strawberry plant, the following results are briefly summarized:

1. The strawberry false-worm has but one brood each year in Missouri, the larvae hatching at about the time the first blossoms appear on the plants and continuing until the berries are ripe.

II. By thoroughly dusting fresh and pure pyrethrum among the plants, we can kill a large per cent of the worms, and hold them in check so as to prevent any serious damage. As this substance is absolutely harmless to man, it can be used with perfect safety at any time, even when the fruit is fully ripe and ready

to pick. Two or three applications may be necessary to kill the bulk of the larvae in severe attacks. This method is too expensive for anything but home patches or those supplying a home market.

III. The larvae may be practically all killed and further damage prevented, by thoroughly spraying the plants once or twice immediately after the larvae appear and before the first berries are more than one-third grown, using for this purpose either fresh powdered hellebore in the proportion of one pound of hellebore to each three gallons of water, or one pound of Paris green and three pounds of fresh lime in one hundred and fifty gallons of water.

IV. Powdered white hellebore, which must be fresh and unadulterated, is the best and safest all-around substance to use, since it kills the larvae readily, is less poisonous to man than the arsenics, and soon loses its strength or poisonous property after it has been sprayed on the plants. Hence there is no danger connected with its use if applied as directed.

V. The common strawberry leaf-roller is the most frequent and destructive insect pest infesting the strawberry plants in this State, and especially in the Ozark region, where the large commercial fields are located.

VI. There are three distinct broods each year in South Missouri, and as a result, the insects are found, in one stage or another of their existence, in the strawberry plants during the entire summer.

VII. There is no practical method of combating the first brood; but the second or the third may be practically exterminated by burning over the fields during

the middle of July or the middle of September while the larvae or pupae are within the folded leaves. By thus destroying either the second or the third brood, the first brood the following spring will not be numerous enough to cause serious trouble.

VIII. The strawberry plants should be mowed and allowed to dry for two or three days in the sun, then covered with a loose coat of straw, or the mulching raked up over them, and the whole burned preferably while a gentle wind is blowing in the direction of the rows. If the plants are very thick and matted, it may not be necessary to add straw, while if they be extremely thin, it may suffice to simply cover them with the straw or mulching and not mow them. This burning over of the plants will not injure them in the least and they will soon develop a new set of leaves practically free from the leaf-roller.

INTRODUCTION.

Within the past few years the production of strawberries within our State has increased many fold. This is especially due to the rapid increase along this line in the southern or Ozark region, where former growers have extended their acreage in this crop alone, until whole farms are now devoted to this specialty, and large numbers of smaller producers have turned their attention more or less to strawberry growing, and have, by their success, induced thousands of individuals to take up this production on a still smaller scale. The result of all this has been the wonderful increase in acreage devoted to this one crop, and the phenomenal record of upwards of four hundred car loads of straw-

berries shipped from one small section in a single season.

As might be expected, this great increase of acreage in so small a region has finally caused the various insects that prey upon the strawberry plant to increase and become troublesome, and failures in crops due to this cause alone are now frequent.

At the earnest request of several extensive strawberry growers, that tests of various methods for suppressing the more common strawberry insects be made, with a view to find the cheapest and most effectual plan for them to follow, this station took up the work in the field, and the results of these experiments are here given.

The Strawberry False-Worm.

Harpiphorus maculatus, Nort.

This insect is sometimes spoken of as the strawberry slug, and, although not as slug-like as the rose slug and many other members of the family Tenthredinidae, it belongs to the same family of insects. The slugs or worms are the larvae of a Hymenopterous insect that to the casual observer might be mistaken for a bee, due especially to the appearance of the wings.

Adult.—The adult saw-flies are a little less than one-fourth of an inch in length, and one-half inch in the expanse of their wings. The two pairs of wings are provided with a greater number of veins than is

found in the bees, and the body is black with a row of spots down each side of the abdomen, giving the appearance of an interrupted band of a brown color in the females and whitish in the males. The head is prominent and transverse, and if examined under a lens, will be seen to be finely punctured with wide channels at the sides of the ocelli, and a ridge down the nasus. The antennae are conspicuous, rather stout, filiform, and nine jointed, with an indication of serrate structure, and with the third joint the largest; the antennae long enough to reach to the abdomen, and in the males flattened. The abdomen is cylindrical in the males and carinate in the females, and suddenly compressed at the apex. The legs are brownish or whitish in color. Figure 1 represents one of these insects enlarged.

Pupa.—The pupa is of a dull greenish white color, with the legs, antennae and wing pads of a lighter shade.

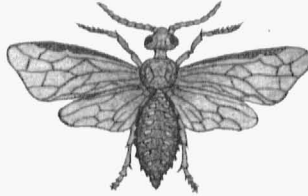


Fig. 1.—Adult Strawberry False-Worm, *Harpiophorus, maculatus*, Nort. enlarged.
(Original.)

Larva.—When full grown the larvae are a little over one-half inch in length, of a greenish yellow color, with a decided green colored interrupted band along the sides, and dirty yellow below, and with a pale or whitish band along the back. The head is yellow with two brown spots on the side and one or two on top.

The three pairs of true legs and the eight pairs of fleshy prolegs are yellow.

Egg.—The eggs are oval and white, and about three-hundredths of an inch in length.

HABITS AND LIFE HISTORY.

The adult flies emerge in early spring, usually during the latter part of April, but in some seasons even during the fore part of that month. They can then be found depositing their eggs on the strawberry plants, which they do by inserting their ovipositor through the epidermis of the leaves as a rule, but in some few cases the upper portion of the petiole, and inserting a single egg in each incision. By keeping very quiet I have been able to watch these flies oviposit many times; but have seen only one deposit an egg in the upper portion of the petiole of a leaf, and am, therefore, inclined to think that Prof. Riley's observations in this respect are very exceptional.

Before the eggs hatch, they increase somewhat in size, and can then be quite readily detected beneath the epidermis of the leaves which are somewhat swollen at that point. The young larvae begin to emerge in two weeks after the eggs are deposited, and at once commence to eat holes in the leaves. This they continue to do until full grown; and where numerous, they will depoliate the plants to such an extent as to greatly injure or completely destroy the crop of fruit, and may even kill the plants themselves.

Larvae were hatching in the fields on the twentieth of April, 1898, in Jasper county, Missouri.

The larvae sometimes appear on the plants before

they begin to bloom, but more frequently they begin to appear at the same time, and their injuries increase as the plants increase their bloom. As the larvae grow they moult four times before they become full grown, which usually requires about five weeks. They have the habit of coiling up in a spiral on the under side of the leaves with the tail end in the center. This seems to be their attitude when at rest or when disturbed; but if the disturbance be too great, they drop from the leaves and roll to the ground; or, if feeding, they will curl up and drop to the ground when the plants are suddenly agitated to any considerable extent.

When the larvae are full fed, they enter the ground a short distance and, by wiggling the body, press the earth away and make a very fragile cocoon by lining it with gum. In our breeding cages the larvae commenced to enter the earth the twenty-fifth of May. After the larvae have made their frail cocoons, they begin to draw themselves up more and more, until finally their bodies are considerably contracted in length. They then remain in this condition throughout the remainder of the summer and during the winter, and transform to pupae early in the spring. In our breeding cages we found some of them pupating on the third of March and did not disturb them after that. The first adult emerged on the twenty-ninth of May; but I am inclined to think this was due to their having been kept in a comparatively warm room, since we could not find adults in the field in the southern part of the State until the tenth of April.

In spite of the fact that we fully expected to find two broods of these saw-flies in the southern part of this State, two years careful searching has failed to

reveal any trace of the second brood that Prof. Riley mentions in his Missouri Report on this insect. We know that but one brood has been found in the states north and east of us, but as many insects that are single brooded in the northern states are double brooded in the southern, we still expected to confirm the reports of Prof. Riley. It is evident, therefore, that he has made a mistake, since, even should we have simply failed to find the second brood in the fields, the life histories of this saw-fly as revealed in our breeding cages for two consecutive years absolutely precludes the possibility of there being a second brood, for in all cases the larvae showed no inclination to pupate the same summer. It is unfortunate from an economic standpoint that the facts should be as they are, since, if the second brood were a reality, they would appear on the plants after the fruit had been gathered, and it would then be a very simple matter to apply a poison to them and kill all the larvae and thus prevent the first brood from becoming numerous enough the following spring to do any damage.

REMEDIES.

The fact that this insect is single brooded, and that the larvae appear at about the same time as the blossoms, and continue to cause their depredations until the fruit is gathered, has led to the general belief that this pest is a very difficult one to combat, owing to the inadvisability of applying either hellebore or arsenical poisons at that time. Our experiments in the fields of South Missouri, however, lead us to believe this pest can be safely controlled with comparatively little dif-

ficuity in most cases. Advantage was taken of the fact that the larvae were apparently all hatched by the time the first flowers (petals) had fallen, and the plants were just starting to bloom in abundance, but the bulk of the flowers had not yet opened.

At this time—first flowers had just fallen—we selected twenty consecutive rows across a large field, and sprayed them at once with a pound of Paris Green and three pounds of fresh lime in one hundred and fifty gallons of water. Then leaving twenty rows untouched as checks, we sprayed another twenty rows with fresh powdered white hellebore in the proportion of one pound in three gallons of water. Twenty rows were again left untouched as checks, and the next twenty rows dusted with pure and fresh pyrethrum by means of Leggett's Champion Dry Powder Gun, an illustration of which is shown in figure 2.

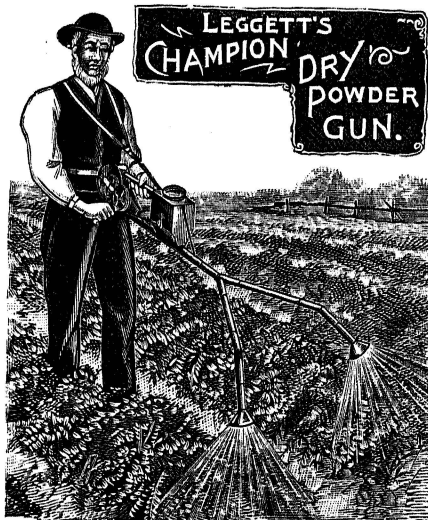


Fig. 2.—Dusting Strawberry Plants with Pyrethrum by means of the Champion Dry Powder Gun.

When the first berries were about one-third grown, we again sprayed the first ten rows of the twenty previously sprayed with Paris green with the same Paris green mixture as before. We likewise sprayed again the first ten rows of the twenty previously sprayed with hellebore, with the same mixture of hellebore as before, but freshly prepared; and dusted again with pyrethrum the first ten rows of the twenty previously dusted with this substance.

The results from our applications of the above insecticides for this insect were very marked. All the rows that were left as checks suffered greatly by having the leaves badly eaten, while the rows that were treated, were more or less exempt as stated below.

Pyrethrum.—The twenty rows that received the application of pyrethrum showed some injury from the insects, but not enough to materially effect the crop of fruit. The ten rows that were dusted twice had about one-half as many larvae as the ten rows that received but one application, but the first application killed a much larger percentage of the larvae than did the second, which was probably due to the fact that the larvae then being smaller were more easily effected and killed. No injury to the plants or fruit could be detected.

Hellebore.—The twenty rows of strawberry plants that were sprayed with the hellebore had a few larvae which were practically all confined to the ten rows that received the first application only. These were not numerous enough, however, to do any injury that season, but would allow more adults to mature the next season than should be the case. The ten rows that received the two sprayings of hellebore were practically

free from the larvae, not enough being left to average over one larva to every six feet of the row. The hellebore was decidedly more effectual than the pyrethrum in killing the insects. As might be expected, no injury to the plants or the fruit could be detected as a result of the hellebore.

Paris Green.—There was a little difference to be noticed in regard to the number of insects on the rows of strawberry plants sprayed with hellebore and on those sprayed with the Paris green. The Paris green seemed to be more effectual than the hellebore in its work of destroying the larvae, although nothing like the difference observed between the use of pyrethrum and hellebore. In the ten rows that were sprayed twice with Paris green, it required considerable searching to find a single larva, not averaging more than one to every ten feet of the row. There were more larvae in the ten rows sprayed but once, yet one had to look carefully to find them even there. No injurious effects could be detected on the plants or the fruit as a result of the spraying with Paris green.

When the fruit first commenced to ripen nicely, I gathered two quarts from the rows sprayed twice with Paris green and two quarts from those sprayed twice with hellebore, and, without washing them, I ate all in one day without any indications whatever of injurious effects. As is usual in the spring, there were several rains between the time of spraying and the gathering of the berries, but not an unusual amount. The berries I ate were intentionally not washed; and when we consider that they should always be washed before eating, the chances of becoming poisoned or in-

jured in the least by eating ripe strawberries that were sprayed with either hellebore or Paris green when only one-third grown, are practically null.

In practice, we doubt whether pyrethrum can be used economically on a commercial basis against this insect in the large strawberry farms, or in the strawberry regions, at the modern market price of strawberries. It is excellent for the home strawberry patch, or for those who have a home market; but for those with large fields or in strawberry regions where the berries have to be all shipped, the pyrethrum method is too expensive, and the results not as satisfying as other cheaper methods, like the use of hellebore. In the first place the pyrethrum must be absolutely *pure* and *fresh* in order to be of practical value. It is next to impossible to purchase it from local dealers in this condition, and it must, therefore, be purchased from some reliable wholesale chemical house. If fresh and pure, it will cost at least forty cents per pound plus the express to your place; and even if kept in air tight cans, it will lose its strength or poisonous properties if kept from one season to another. The pyrethrum is perfectly harmless to man and domestic animals, and is, therefore, to be preferred on that account to a poison for the home garden. It requires for each application four pounds of pyrethrum to every acre of strawberry plants.

We believe that powdered hellebore, which must also be *fresh* and *pure*, will prove to be the best insecticide for this strawberry false-worm on a commercial basis in large fields or in strawberry growing regions, where all the fruit is shipped in order to be sold. The reason why we say hellebore instead of Paris green

is that people will, no doubt, fear the use of Paris green, even when the fruit is not one-third grown; and most growers are very apt to put off spraying too long, to see whether it is really necessary or not, and by that time, some of the fruit may be developed too much to spray with the Paris green. And, furthermore, hellebore is not so poisonous to man as Paris green; and has this additional advantage, that it soon loses its strength or poisonous properties—the alkaline jervine when exposed to the air, as it is when sprayed on the plants. For these reasons it can be safely used after the berries are developed more than one-third, although we do not recommend its use after that period.

It is necessary to purchase fresh hellebore—not hellebore left over from last years stock—and it must also be pure—not adulterated. It will cost about twenty cents per pound, and should be applied in water, in the proportion of one pound of the powdered hellebore to every three gallons of water. This should be sprayed on the plants thoroughly, by means of a force pump and spray nozzle. We have found the “bordeaux” nozzle to give the best results, because it does not so readily clog when using hellebore, which will clog an ordinary nozzle that is adapted to the use of Paris green and other poisons.

Apparatus.—For dusting pyrethrum on strawberry plants we have found nothing so good and economical as the Champion Dry Powder Gun manufactured by Liggett and Brothers, 301 Pearl St., New York, N. Y., and sold for \$7.50 complete. It is so arranged that the amount of powder to be dusted can be regulated by means of a thumb screw, while other dust-

ing machines that we have seen do not possess means for so regulating the amount of powder distributed over a given area. This machine is illustrated in figure 2.

For spraying the plants with Paris green or hellebore, we found the Deming Field Sprayer manufactured by The Deming Co., Salem, Ohio, to give the best results and perfect satisfaction. This sprayer is an attachment which can be used in connection with

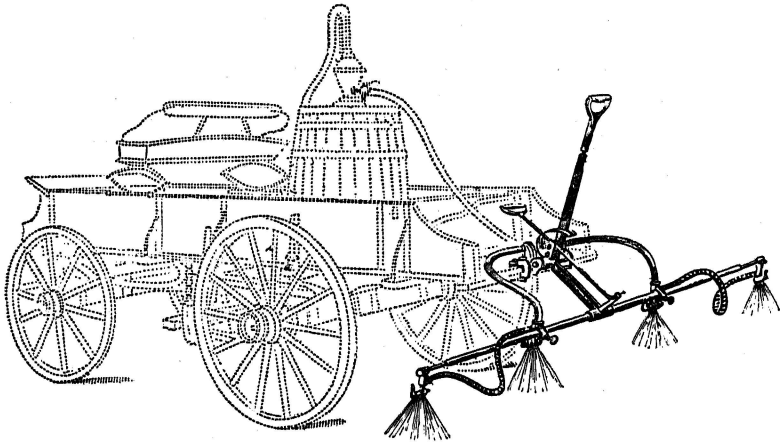


Fig. 3.—The Deming Field Sprayer, attachable to any wagon and used in connection with any force pump.

any ordinary barrel spray pump, and is attachable to any ordinary wagon or cart in such a way as to spray four rows at once. It can be regulated for any distance between rows and elevated to any desired angle. The catalogue price is \$12, but as this attachment can be profitably used for potatoes and other low field crops it is a convenient accessory to any barrel sprayer. This attachment is illustrated in figure 3.

The Common Strawberry Leaf-Roller.

Phoxopterus comptana, Frohl.

In South Missouri, where our strawberry industry has become noted, the leaf-roller is undoubtedly the most common, troublesome and injurious insect pest affecting that crop. It has absolutely ruined several large three year old patches, greatly reduced the yield of many others, and threatened destruction in whole regions. Neglected or old beds suffer most, but it is generally found more or less numerous in all strawberry beds, where it remains the year round in one or another of its stages.

This insect was formerly confined to the northern and eastern states, but has gradually worked its way southward, until it is now found in Northern Arkansas as well as in Southern Missouri.

As this insect occurs in Europe, where it was first described in 1828, it is probable that it was introduced from there into America some time prior to 1867, at which time we find the earliest notice of its occurrence in this country in the "Canadian Farmer" for August, 1867. The first description of the insect in America, however, appeared in an article on the subject by Walsh and Riley in the "American Entomologist" for January, 1868, under the name of *Anchylopera fragariae*. Strangely enough, this insect seems not to feed upon strawberries in Europe, but upon members of the same family. In this country, however, it is practically confined to the strawberry, but is occasionally found on raspberry and blackberry; in one in-

stance, which came under my observation, doing considerable damage to a six acre patch of the latter.

Adult.—The adult leaf-roller is a small moth measuring from four-tenths to nearly one-half an inch in the expanse of its wings. The head and thorax are of

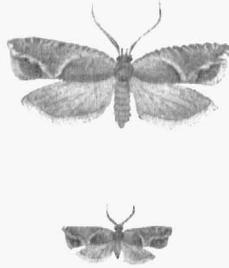


Fig. 4.—Adult Strawberry Leaf-Roller, *Phoxopterus comptana*, Frohl. The Upper Figure Enlarged, the Lower Figure Natural Size. (Original.)

a light reddish to ash brown color; abdomen pale fuscous above and paler beneath; palpi fuscous on outside, lighter at base and inside than at tip; antennae dark fuscous. “Fore wings with a large, semi-ovate spot of the same brown color as the thorax, resting on the basal half of the hinder margin, and extending two-thirds of the way across to the costa, where it is not always clearly limited from the costal third of the wing, which is white, tinted with brownish or ochery and marked with a series of minute brown costal streaks with more or less sprinkles of the same color. The outer edge of the semi-ovate spot varies somewhat in form as in other species of this genus. The ground color of the basal half of the costa, changing more or less to a silvery grey in its course, extends across the wing beyond the semi-ovate spot, as a narrow, oblique band, to the hinder margin, where it expands outward

and upward, covering a large area on the anal angle and including an oblique brown spot before the angle. The part of the wing above this is concolorous with the semi-ovate spot and marked on the outer half of the costa with four pairs of oblique white streaks, the inner one of which extends to the outer margin a little below the middle. Some specimens show one or two horizontal black streaks near the middle of the outer part of the wing. Fringes sordid white or tinged with ochery, brown at the apex and cut immediately below by two white streaks with brown between. Hind wings and abdomen above, pale fuscous, paler beneath. Under side of the fore wings, fuscous and showing the costal marks of the upper side." (Fernald.) Figure 4, represents an adult natural size and enlarged.

Pupa.—The pupa is about three-sixteenths of an inch long, of a pale brown color, and slender-ovate in shape. The ventral surface of the abdomen is smooth with hooks at the caudal extremity; the segments of the dorsal surface are each provided with two transverse rows of short spines on the cephalic and caudal margins, excepting the last segment which has three rows.

Larva.—The larvae when full grown are about one-third of an inch in length. The first segment is the largest, and each succeeding one is a trifle smaller, so that the body gradually tapers to the caudal extremity. The color varies from light yellowish brown to dark olive green; the body is dull and somewhat translucent; the piliferous spots large, shining, light in color, and contrasting with the general color of the body. The hairs are stout and stiff. Segments two and three have no spots on their caudal half, otherwise

the spots are normally arranged. The head is horizontal and of a shining pale yellow or fulvous color, with a dark eye-spot and tawny upper lip. The cervical shield is also shiny. The anal segment has two black spots at the caudal edge which in some specimens coalesce. The legs, prolegs and ventral surface of body is of the same color as the general body.

Eggs.—The eggs are lenticular in shape, of a translucent pearly white, somewhat iridescent, and coarsely reticulated.

HABITS AND LIFE HISTORY.

The adult moths begin to emerge early in the spring when the first warm spells appear. Last year they were seen flying about the plants in the fields of South Missouri on the tenth of April, although the first moths did not emerge in our breeding cages at the station in Central Missouri until the fourteenth of that month. Within a week the moths became very numerous, and commenced to deposit their eggs singly upon the upper surface of the leaflet as a rule, placing the eggs in the groove along a leaf vein, rarely placing more than one egg on a leaflet. In from two to three weeks the eggs hatch into minute whitish larvae with brown heads. These creatures begin at once to feed and to spin a delicate silken web, under which they are found, and which protects them to a certain extent, and renders the application of arsenical poisons, even at this early stage, practically useless. They grow rapidly, and soon begin to fold the leaves by spinning silken cables across the leaflet and gradually bring the upper surface of one-half of a leaflet over and in con-

tact with the upper surface of the other half, and fasten it there by means of silken threads. A glance at figure 5 will give one an idea of the manner in which these larvae fold the leaflets.

Within this folded leaflet the larva remains and feeds, protected from the application of insecticides, and more or less protected from the attack of predacious and parasitic insects, and from birds. The larvae do not eat entirely through the leaves, but leave the

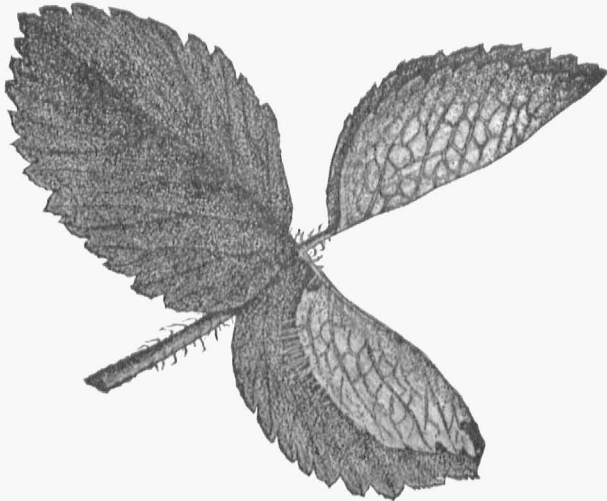


Fig. 5.—Strawberry leaf, showing leaflets folded by the Leaf-Roller.

lower, or in the folded leaflet the outer, epidermis intact. The leaves thus folded soon turn brown, cease to be of value to the plant, and, when numerous, give the field the appearance of having been burned over.

By the thirtieth of May the larvae become full grown and begin to change to pupae within the folded leaves. Last year they had apparently all pupated by the tenth of June. On the eighth of June the first

moths of this first brood appeared in the breeding cages, and a few days later were numerous in the fields. The last moth of this brood to appear in our breeding cages, emerged on the twentieth of June. As soon as they emerge, these moths begin to mate and to lay eggs for a second brood.

The larvae of the second brood commenced to hatch in the fields on the twenty-ninth of June, and the first pupae were observed on the twenty-third of July. The adult moths of the second brood began to emerge on the first of August, and after mating began to deposit eggs for a third brood.

In the fields the first larvae of the third brood appeared on the seventeenth of August, and were apparently full grown on the thirteenth of September, but they did not pupate as we expected. These full grown third brood larvae remained in the folded leaves until the second of October, at which time many of them left the leaves and crawled under the rubbish and mulching about the plants. On the sixteenth of November, a search was made for pupae, but without success, although the larvae were found in great abundance. Another search for pupae was made on the fourth of April, and it was then found that all the larvae had pupated.

It is therefore proven beyond a doubt that this insect has three broods each year in South Missouri, although Prof. Riley in his Missouri Reports says the insect is double brooded; but it is evident he bases all his statements on the insect as found in Central and Northern Illinois, and not in Missouri.

REMEDIES.

It was confidently expected that we would be able

to spray the strawberry plants with an arsenical poison, early enough before the larvae folded the leaves, to cover the leaves sufficiently, and that it would remain there, and be eaten by the larvae as they hatch with their first meal, and thus kill them before they could fold the leaves, and thereby be protected from further operation of this nature. This experiment proved to be of no practical value, however, since the rains are so frequent in the spring that they wash off the poison before the larvae all hatch, and also, since it was found that the larvae spin a protective covering of silk over a portion of the leaflets very soon after hatching, so that it required too frequent sprayings to catch these creatures in time and before this covering was formed. If it were not for this protective silken covering, under which they feed, it would be comparatively easy to kill them before they could fold up the leaves.

Fortunately, however, we have one comparatively cheap, easy and efficient means of killing them, and of preventing their undue multiplication and injury, and that is by burning over the fields while the larvae or the pupae are within the folded leaves. This method was tested on several fields for two years, and with perfect satisfaction. The burning is to be done during the middle of July, or frequently during the middle of September, at which time the larvae of the second (July) or third (September) broods will be found in the folded leaves. One should look at the plants carefully to ascertain the exact time, however, but the above dates will usually be found to be correct.

The proper method of burning is to first cut or mow the vines and allow them to dry one or two days in the sun, then cover them with loose straw or rake up

the mulching, and set fire to the rows, preferably when a gentle wind is blowing in the direction of the rows. Should the strawberry plants be very thick, it may not be necessary to cover them with straw in order that they may burn up properly. Should the ground be too stony to allow of mowing, or should the plants be very thin, they may be simply well covered with straw and thus burned with good results; but it is always well to first mow and dry the plants if possible. This burning over of the strawberry fields will not injure the plants in the least, and they will at once put forth a new growth of leaves that will be practically free from the leaf-roller.

The station is indebted to the Kansas City, Fort Scott and Memphis Railroad Company, and to the St. Louis and San Francisco Railroad Company for numerous courtesies and material assistance in conducting these experiments along their respective lines.