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The Agricultural Experiment Station.

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TWO INSECT PESTS,

The Codling Moth and The Grape-Vine Leaf-hopper.

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TWO INSECT PESTS.

The Codling Moth and The Grape-vine Leaf-hopper.

BY

C. P. GILLETTE, *Entomologist.*

INTRODUCTION.

As the writer has been but a few months in Colorado it is impossible that the present bulletin should present new matter which is the result of personal investigation here.

The chief object of the bulletin is to give needed information on two insect pests, the Codling Moth and the Grape-vine Leaf-hopper, concerning which many complaints have been received at the experiment station.

A secondary object of the bulletin is to solicit the co-operation of the people of the state in the work of investigating insect ravages upon plants and animals. Whenever insect injuries are noticed, specimens of the insects doing the damage with the fullest information possible concerning them should be forwarded to the experiment station. Such communications will receive prompt attention and the best known remedies will be recommended in return.

When insects are sent by mail, they should be inclosed, with a supply of their natural food, in a strong tight box. Holes in the box for air are unnecessary and should not be made.

THE CODLING MOTH,

Carpocapsa Pomonella, L.

The Codling Moth is not a native of America but was imported from Europe about one hundred years ago. As a large number of the worms of the fall brood do not leave the apples until the latter are stored in cellars or in barrels, this insect is unavoidably introduced wherever apples are shipped. Consequently it has spread rapidly, not only in this country, but to nearly all parts of the globe where apples are grown from cold Siberia to sub-tropical regions.

LITERATURE.

The amount of literature that has accumulated on the Codling Moth in this country is very great and, in a considerable part, especially that occurring in local news papers, is of little value. It would be useless to endeavor to give anything like a full bibliography of this insect in the present paper, but, for the benefit of those who wish to go deeper into the subject, I will recommend the following articles as being especially valuable and easy of access:

Miscellaneous Essays on Economic Entomology, by Dr. S. A. Forbes, State Entomologist of Ill., 1886.

Report of the United States commissioner of Agriculture for 1887, page 88. Paper by Mr. L. O. Howard.

Bulletin 39 of the Michigan Experiment Station by Prof. A. J. Cook.

First Annual Report of the Kansas Experiment Station, page 1. Paper by Prof. E. A. Popenoe, Mr. C. L. Marlatt and Mr. S. C. Mason.

Bulletin 3, Second Series, of the Ohio Experiment Station by Dr. C. M. Weed.

Bulletin 7 of the Iowa Experiment Station by C. P. Gillette.

POPULAR DESCRIPTION.

The mature insect is, as the popular name implies, a moth, or, as such insects are often called, a miller. Figure 1, f and g are illustrations of the moth. About two thirds of the basal portion of the anterior wing above is ashen gray crossed by narrow broken lines of brown. Near the outer margin of the wing there is a large brown area occupying nearly one third of the wing surface within which are numerous gold or bronze colored scales and also a few scales that are entirely black.

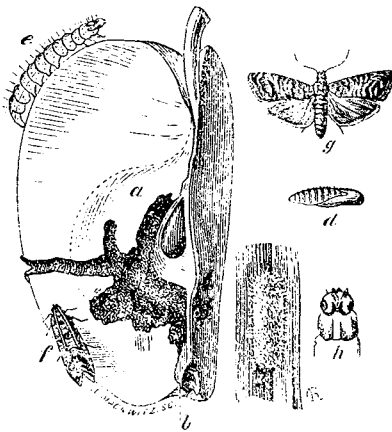


Fig. 1.

The posterior wings are of a dingy brown color being lighter near the body.

The larva, or worm, is too well known to need a careful description. All who have eaten apples have seen the apple worm (Fig. 1, e.) of a pinkish

or flesh color and about three fourths of an inch in length when full grown.

The brown shining chrysalis is shown in the cut at *d*, and the silken cocoon that always surrounds it at *i*.

All of the illustrations in the figure are natural size.

LIFE HISTORY.

Professor James Cassidy, in Bulletin 6 of this station, page 2, says that in that year (1888) the moths were plentiful towards the end of April. According to the meteorological record of that year April was a very warm month at this place, the lowest morning temperature being 38° and the noon-day temperature being, much of the time, above 70°. The time of appearance will always depend on the earliness of the season and upon the warmth of the particular place in which the insect winters. There is also a considerable difference of opinion among writers as to the time when the moths begin to deposit their eggs.

From careful observations made in Iowa the writer concluded * that the eggs did not hatch there until a month, at least, after the flowers fell from (Duchess) apple trees.

As bearing upon this subject I quote the following from an article that appeared in the Pacific Rural Press of June 8th 1889 from the pen of Mr.

* *Bulletin 7 of the Iowa Experiment Station, Page 277.*

D. B. Wier, a well known writer upon horticultural subjects. Mr. Wier says:

"I looked over an orchard very carefully on May 26th, and could find no instance where a larva had penetrated an apple. * * * * To-day, May 28th, in the same orchard, a search of an hour rewarded me with 20 apples in which the larvæ had penetrated the fruit sufficiently to make a showing; they were from an eighth to a twentieth of an inch in length, showing that they were only from one to four days from the egg. * * * * To-day the apples here at Petaluma are well grown, averaging over $1\frac{1}{2}$ inches in diameter."

The exact time at which the moths begin to deposit their eggs, will also vary greatly in different years but it is quite safe to say that egg-laying does not take place to any considerable extent until the flowers have fallen from the late varieties of apple trees. The eggs are deposited one in a place in the blossom or calyx end of the apples and it has been estimated that each moth deposits at least 50 eggs. Within a few days after the deposition of the egg, the time dependent on the temperature, the larva hatches. It feeds for a short time within the calyx and then begins to burrow towards the core of the fruit within and about which it feeds until fully grown when it gnaws an opening, usually at the side of the apple, and escapes to go in search of a suitable place to spin its cocoon and transform to the pupa or chrysalis state. About two weeks later, probably about the 5th of July in Colorado, the moths of the second brood begin to appear which soon begin to lay eggs for a second brood of the worms. This brood does far greater harm than the first unless the first have been mostly destroyed, in which case there are comparatively few moths to lay eggs to produce a second brood.

FOOD PLANTS.

The Colding Moth, though partial to the apple, also attacks the pear, quince and wild haw and has, in rare cases, been reported as feeding in pit fruits as peaches, plums and apricots.

NATURAL ENEMIES.

Nature's checks upon this insect are numerous but very ineffectual. The more important natural enemies are insectivorous birds, and two species of insect parasites belonging to the family Hymenoptera to which family belong all our ants, bees and wasps.

ARTIFICIAL REMEDIES.

Under this head I will mention first the use of the arsenites, London purple and Paris green, as they are by far the most important.

Who first used arsenic in any of its forms for the destruction of Codling Moth larvæ it is impossible to say. Among those who were early in bringing London purple and Paris green into popular use for the destruction of this pest are Prof. A. J. Cook of the Michigan Agricultural College, Dr. S. A. Forbes of the Illinois State Laboratory of Natural History, and Prof. E. S. Goff formerly of the State Experiment Station, at Geneva, N. Y.

Within the past few years a great many entomologists and practical fruit growers have used these arsenites for the destruction of the apple worm and, so far as I can learn, there has been but one verdict where a fair trial has been made and that is in favor of the application.

* Professor Goff in his experiments in 1884 sprayed six trees three times with Paris green and compared them with four trees not treated. All of the apples, 9,198 in number, that grew on these ten trees were examined and it was found that 69 per cent. of the injury was prevented on the treated trees. That is, there were but 31 wormy apples on the treated trees where there would have been 100 wormy apples in the absence of the treatment.

Dr. Forbes, in 1885 conducted a similar but more extensive experiment from which he concluded as follows:

"The experiments above described seem to me to prove that, at least, seventy per cent. of the loss commonly suffered by the fruit growers from the ravages of the Codling Moth or apple worm, may be prevented at a normal expense, or, practically, in the long run, at no expense at all, by thoroughly applying Paris green in a spray, with water, once or twice in the early spring, as soon as the fruit is fairly set, and not so late as the time when the growing apple turns downward on the stem."

While employed at the Iowa Experiment Station in 1889 I conducted experiments for the destruction of Codling Moth larvæ by using London purple and Paris green and reported upon them in Bulletin 7 of that station. In one of these experiments three Duchess apple trees were sprayed once, May 18th, with a mixture of London purple in water in the proportions of one pound to 128 gallons and two other trees of the same variety were

* *Fourth Annual Report of the State Experiment Station, page 218.*

Miscellaneous Essays on Economic Entomology
p. 26. Also *XV Annual Report of the State Entomologist of Illinois, page 7.*

sprayed with the same mixture May 18th and again May 7th. Four other Duchess trees adjoining the above, not treated, were used as checks. At the end of the season it was found that the treated trees had 68 per cent. less of wormy fruit than those not treated, or, there were but 32 wormy apples on the treated trees where there would have been 100 if the treatment had not been made. The percentage of apples saved agreed remarkably well with the results obtained by Professors Goff and Forbes above mentioned. I also tried in 1889 a new method of applying the poison to apple trees which was to mix Paris green very thoroughly with common land plaster in the proportion of one pound of the poison to 100 pounds of plaster and throw the mixture over the trees from the top of a step ladder in the early morning while the dew was still on the foliage. Two trees were treated in this experiment and when brought into comparison with the check trees showed a saving of over 94 per cent. of the fruit that would have been wormy in the absence of treatment. I do not suppose it would be advisable to apply the poison in this manner on a large scale but it may be a desirable method where a few trees are to be treated and no force pump is at hand.

That it pays and pays richly to spray apple trees for the destruction of the Codling Moth larvæ there can be no doubt. It is the unanimous verdict of thousands of practical orchardists in the East who have given this subject a thorough trial and come to consider the spraying of their fruit trees quite as essential to the production of a good

crop of apples as cutting the weeds from their garden for the production of a crop of vegetables. As to the form of the poison to use, and the method and time of application that will produce the best results, there is still much to be learned.

THE POISON TO USE.

Some of the earliest experiments * with poisons for the destruction of the apple worm were made with white arsenic in solution and seemingly with good results. This substance, however, is objectionable because of its color which makes it liable to be mistaken for culinary articles, because, unless dissolved, it mixes with much difficulty in water and when mixed settles quickly to the bottom of the vessel and, because, when in solution it is very injurious to foliage, as proven by a large number of experiments by myself which were reported in Bulletin 2 page 30 and Bulletin 10 page 413 of the Iowa Experiment Station,

London purple and Paris green are the two substances most commonly recommended and used for insecticidal purposes and, of these two, the former seems to be growing in favor on account of its being cheaper, less liable to adulteration and lighter, so that it remains longer in suspension in water. On the other hand, experiments ** go to prove that Paris green is less injurious to foliage than London

* *See paper by Hon. J. N. Dixon in Rep. of Iowa State Horticultural Soc. for 1882.*

** *Bul. 53, page 6, of the Mich. Exp. Sta. Also Bul. 10 page 404 of the Ia. Exp. Sta.*

purple when applied in the same proportion. But I found from my experiments * of last year and the year before that the injury which London purple usually does to foliage can be almost wholly prevented by the addition of a small amount of quick lime to the water, enough to make it appear quite milky when stirred.

Strength to Apply.—Whether London purple or Paris green is employed I would recommend that it be used in the proportion of one pound to 160 gallons. If London purple is used, I would recommend the addition of the lime as mentioned above. If a second application is made, do not use stronger than one pound to 200 gallons.

The liquid should be stirred frequently, especially if Paris green is used, to keep the poison well mixed through it.

Time to Apply.—It is almost universally recommended that spraying should take place as soon as the flowers fall. I am satisfied that in case of early varieties, there are two or three weeks, at least, after the flowers fall before the worms begin to eat into the fruit.

I found ** in 1889 that Duchess apple trees dropped their bloom fully one month before the worms entered the fruit.

As the calyx closes very much after the apple begins to form, so that less poison would be retained there, and, as the apples soon turn downward on

* *Bul. 10, page 412, Ia. Exp. Sta.*

** *Bul. 7, page 277, Ia. Exp. Sta.*

the stem after forming, it is probably advisable to make the first application not later than one week after the flowers fall. If the application is thoroughly made, and no heavy rain follows to wash away the poison, a second application will hardly be needed. If a heavy rain does follow soon after the first application, the trees should be sprayed again with a somewhat weaker solution than at first.

As to pumps and other machinery with which to make the applications see article on spraying machinery.

COLLECTING UNDER BANDS.

Next to the arsenites the use of bands fastened around the trunks of the trees about the last of June, under to which to collect the larvæ of the first brood for the purpose of destroying them is probably most useful if faithfully attended to. The bands may be of hay, paper, burlap or other cheap material that will form a good hiding place for the insects while in the pupa state. These bands must be inspected every three or four days and the larvæ and pupæ found beneath them destroyed. In this manner the second brood, will be largely prevented from appearing.

Another partial remedy is to allow sheep or swine to have the run of the orchard as they will destroy large numbers of the worms that are in the apples when they fall.

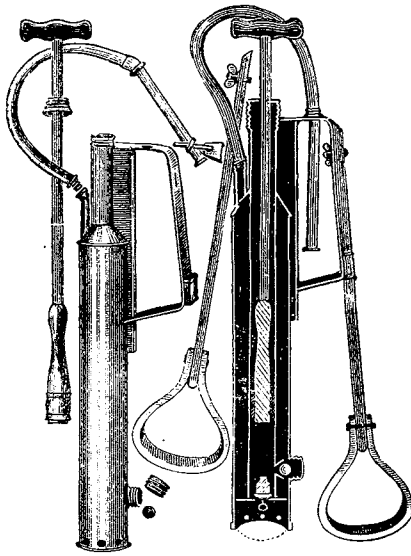
USELESS REMEDIES.

There are many who suppose the moths may be easily captured in dishes of sweetened water or of milk, or about lights put in an orchard. These

supposed remedies are of no value whatever as the Codling Moth never flies to sweets or to light. The large number of moths that are taken in these ways are of other species, largely those of cut-worms.

SPRAYING MACHINERY.

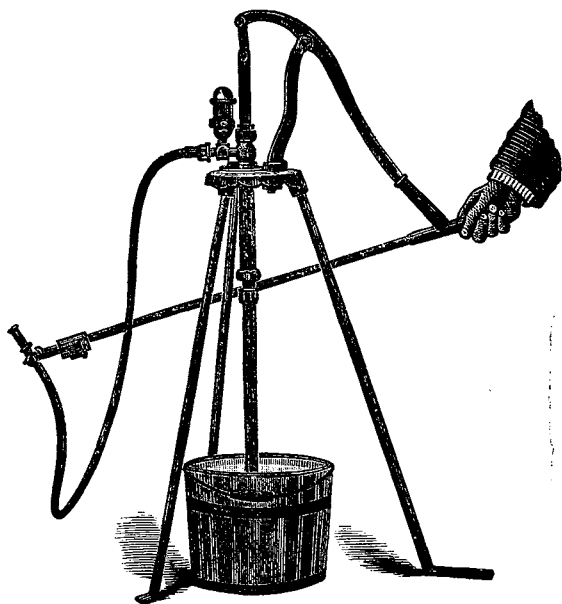
The question "Where can I get suitable pumps to do my spraying?" is so often asked that it seems best to mention a few of the pumps in common use that have been tried and known to be good.



(Fig. 1.)

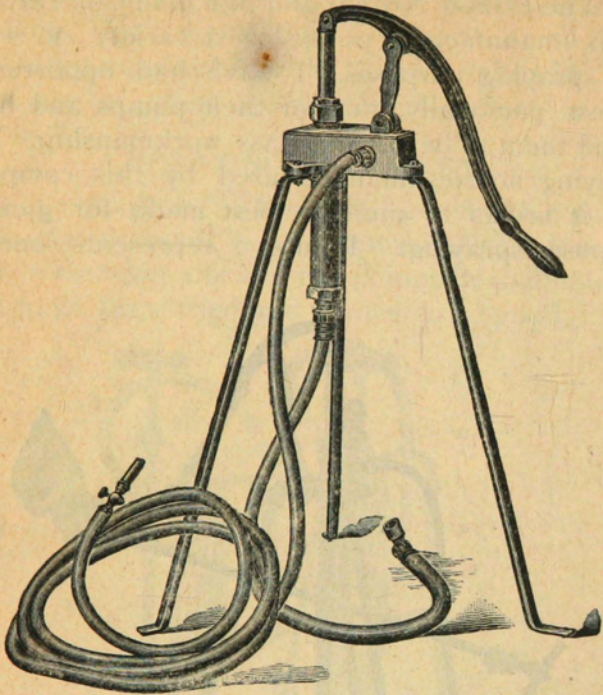
Figure 1 is a representation of a force pump made of heavy tin with valves all of metal that I have found very satisfactory where a small amount of spraying was to be done. It is very durable and light and costs about (\$2.00). It is the best cheap pump that I know of. It is manufactured by I. W. Numan, Canton, Ohio.

The Nixon Nozzle and Machine Co., Dayton, Ohio, manufacture pumps in a variety of styles for spraying purposes. I have had opportunity to test, personally, most of their pumps and have found them to be of first-class workmanship. The spraying nozzles manufactured by this company are, it seems to me, the best made for general purpose spraying. Figure 2 represents one of



(Fig. 2.)

the Nixon pumps which is strongly made, of iron and brass. The illustration shows the pump complete with hose and nozzle ready for operation. Its list price is \$10.00.



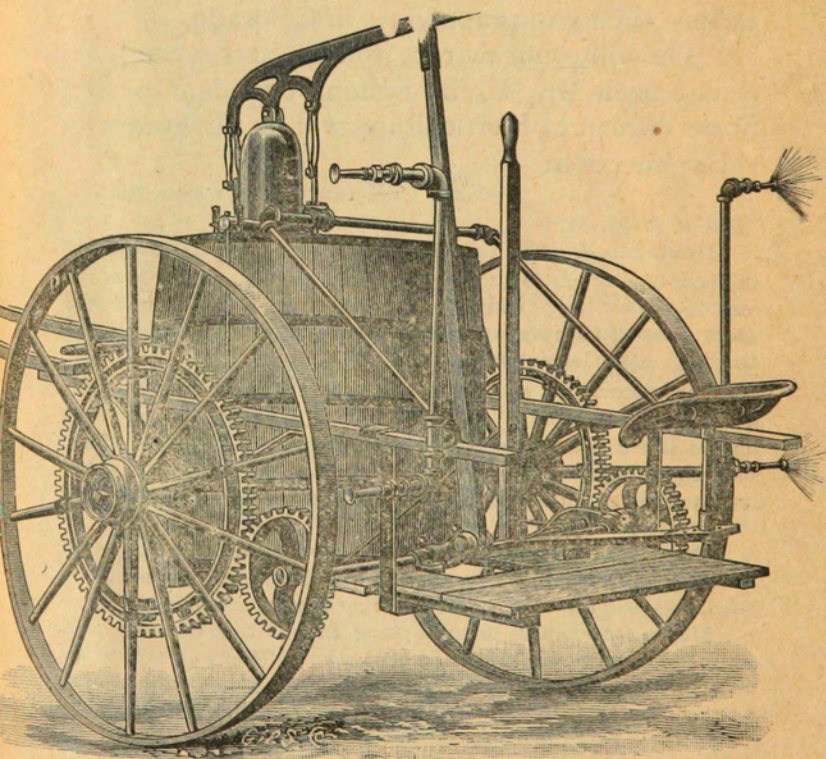
(Fig. 3.)

Figure 3 is a representation of a little heavier pump manufactured by the same company. This pump is arranged so that by removing the legs it can be fastened to the head of a barrel. With hose and two nozzles it is listed at \$15.00. This company also manufacture several styles of spraying machinery among which is a pump and tank mounted on two wheels so that the pump is run by means of gearing and is suitable for field or orchard work.

The Field Force-pump Co., Rochester, N. Y., manufacture a pump, (Figure 4,) similar to the pre-

ceding which costs \$65.00, and also a cheaper pump which can be attached to a common wagon wheel and, by fastening the pump to a barrel, the expense of tank and wheels is saved.

If only a small amount of spraying is to be done, and that upon low plants or shrubs, a bellows atomizer, manufactured by Thomas Woodason, 451 East Columbia street, Philadelphia, Pa., will be found to do good work and to be very economical of material. Mr. Woodason also manufactures a



(Fig. 4.)

bellows duster, that is excellent for applying vegetable powders as pyrethrum or hellebore upon plants or for the destruction of flies in-doors.

If local dealers do not handle the above mentioned articles, they may be procured directly from the manufacturers.

THE GRAPE-VINE LEAF-HOPPER.

Typhlocyba vitis, Harr.

The Grape-vine Leaf-hopper, often spoken of by vineyardists as the "Thrip," seems to be a very serious enemy to grape-vines in Colorado.

The following extract from a letter recently received from Mr. W. B. Felton, President of the State Bureau of Horticulture, will be of interest in this connection:

CANON CITY, COLO., MARCH 18th, 1891.

"*Prof. C. P. Gillette,*

DEAR SIR:--Am glad to know that you are going to investigate the Leaf-hopper. It is the great pest of the grape grower here and also on Wheat Ridge and in other parts of the State. It will be a great blessing to have a bulletin from you giving a reliable and thorough method of extermination.

The hoppers that we have do not touch the buds. They appear at the base of the vine in the spring and as the foliage comes out go up and attack the under side of the leaves and breed there. They suck the substance from the leaves and about the time that the grapes would commence ripening the leaves are only skeletons, and the maturing of the grape ceases.

They attack by preference foreign varieties, Delaware and other tender-leaved vines, but when the more toothsome varieties are defoliated, they will attack Concord and other tender-leaved vines.

After a considerable experimenting I found that an emulsion of one gallon of kerosene, one pound of soap and fifteen gallons of water would kill the hoppers and not hurt the foliage. I used this emulsion through the season and the hoppers did not get the better of me, but the emulsion took the bloom off the grapes and left a stain that injured their appearance for the market. Yours truly,

W. B. FELTON."

The Grape Leaf-hopper was first described by Dr. T. W. Harris in 1831 under the name *Tettigonia vitis*. From Dr. Harris' *Insects Injurious to Vegetation* I copy the following popular description:

"In its perfect state it measures one-tenth of an inch in length. It is of a pale yellow or straw color; there are two little red lines on the head; the back part of the thorax, the scutel, the base of the wing covers and a broad band across the middle, are scarlet; the tips of the wing covers are blackish, and there are some little red lines between the broad band and the tips. The head is crescent-shaped above, and the eyelets are situated just below the ridge of the front."

This insect varies a considerable in coloration and several varieties have been described but all have the same habits and can be kept in check by the use of the same remedies.

REMEDIES.

The writer has never lived where the Grape Leaf-hopper was numerous enough to make it seem necessary to apply any remedy and consequently has had no experience in combating it. But from experiments conducted for the destruction of the Apple Leaf-hopper (*Empoasca mali*) which is a very near relative, and a knowledge of the life-habits of the grape-feeding species, it is believed that a course of treatment can be recommended that will greatly lessen, if not entirely prevent its injuries.

The applications that the writer has found effectual in destroying the Apple Leaf-hopper are kerosene emulsion, whale-oil soap and pyrethrum. The cheapest and most effectual of these, the materials for which are always at hand, is kerosene emulsion.

I would recommend that the emulsion be made by the Hubbard formula as follows: Dissolve one half pound of ordinary hard soap in one gallon of water by boiling; remove the soap solution from the fire while boiling hot and immediately add two gallons of kerosene and agitate the whole as violently as possible for a few minutes when it should be a frothy creamy mass that may be diluted to any extent with water. A good way to emulsify the mixture is to use a small force pump and pump the material forcibly back into the vessel that contains it. If a small amount is to be emulsified I have found nothing better to use than an egg-beater.

For the destruction of the Grape Leaf-hopper, I would put one part of the emulsion as above made in about 20-parts of water, which would make the emulsion a little more than 3 per cent. kerosene. The ingredients in a gallon of such an emulsion would cost less than one cent. If it is found on application that this strength is not sufficient to kill the hoppers, the strength can be increased until it will kill them.

The application of the emulsion should be made as soon as the young hoppers hatch and the spray should be directed as much as possible on the under side of the foliage and with a good deal of force. It would also be well to make one application early in the season before the leaves are out for the destruction of the old hoppers, provided they congregate on the vines in large numbers.

The treatment should be repeated as often as necessary to keep the vines comparatively free from the hoppers up to the time of the setting of the

grapes. If it becomes necessary to treat the vines later than this, I would recommend using a pyrethrum tea in the proportion of one ounce of the pyrethrum to three gallons of water to be applied the same as the kerosene emulsion as this will not injure the grapes.

Pyrethrum powder is also sold as Buhach, Persian Insect Powder, Dalmatian Insect Powder, and Insect Powder. The Buhach Manufacturing Co., Stockton, Cal., make what is usually considered the best article. It can be procured directly from the company or through local druggists. Care should be taken to procure a pure article.

Tobacco-water is often recommended for the destruction of leaf-hoppers but it is not as cheap as the emulsion and it would be liable to stain the fruit after the latter had set. Where vines are under glass or can be confined under a tent, these insects may be completely destroyed by fumigating with tobacco or pyrethrum.

Great numbers of the mature hoppers may be captured upon a sheet smeared with printer's ink, tar or other sticky substance and held along the leeward side of the trellis while some one gives the vines a sudden jar.

Great numbers can also be destroyed at night by carrying torches through the vineyard or by burning lanterns over dishes of water as the hoppers are much attracted by light.

Mr. Felton, in the letter above quoted, spoke of a plan he tried last fall of heaping up leaves about the vineyard for the hoppers to collect under and then, on a cold day, sprinkling kerosene over the

leaves and burning them. This plan or some modification of it, for the destruction of the mature hoppers, is what I should recommend as being next to the kerosene emulsion in importance, as mature insects seek such winter protection as is afforded by old leaves, straw or grass.

Whatever plan is adopted, there must be persistent and united action on the part of all the vineyardists in a given locality if anything like extermination is to be expected.

It is to be hoped that all who try any of the above or other remedies will report their success or failures to the experiment station that others may get the benefit of their experience. If opportunity is afforded, experiments will be conducted at the station for the purpose of determining the relative values of the different methods of overcoming this insect and the results will be given to the people of the state through the bulletins of the station.

