

The Agricultural Experiment Station  
OF THE  
Colorado Agricultural College

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Orchard Plant Lice  
AND  
Their Remedies

BY

C. P. GILLETTE  
E. P. TAYLOR

# The Agricultural Experiment Station.

FORT COLLINS, COLORADO

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# ORCHARD PLANT LICE AND THEIR REMEDIES.\*

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C. P. GILLETTE AND E. P. TAYLOR.

The plant lice that are commonly designated as "aphids" have very similar habits, structures, and remedies. These should be known and understood by the farmer and fruit grower who have to contend with them. Nearly all of these lice are rather easily destroyed when proper remedies are intelligently applied to them. Probably the plant lice here mentioned are the most serious orchard pests in Colorado at the present time.

## GENERAL STRUCTURE AND HABITS.

All of the plant lice get their food by inserting a beak and sucking the sap of the plant. They never eat away the tissue of the leaf.

Throughout the entire summer, from spring to about the first of September, all of our plant lice that infest orchard trees, increase in numbers by giving birth to living young. If eggs are laid at all they are deposited by the last brood of females in the fall. From the fact that a single louse is usually able to give birth to from 75 to 150 young, and as they mature in about eight to ten days after being born, it will readily be seen that the plant lice are capable of increasing with wonderful rapidity. This accounts for the fact that the lice may nearly all be killed from a tree and that tree be very seriously infested with the lice again within a few weeks. Usually the last brood in the fall are about one half males and one half females. These females deposit the eggs that live over winter and the lice all die. We have an exception of this rule, however, in case of the woolly apple aphid which lives over winter as young or partly grown lice upon the trunk and branches, and in all stages of growth upon the roots of the trees.

Plant louse eggs usually hatch in the spring a little before the leaf buds begin to open on the trees that they infest. These early lice hatching from the eggs are always wingless in the species mentioned in this bulletin, and are called stem-mothers. These stem-mothers mature in a short time, are all females, and begin giving birth to young lice which constitute the second brood. It is seldom that the second brood of lice have more than a very few winged ones. The remainder of the life history of these lice will be given under the different species treated.

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\*This bulletin is an abbreviated edition of Bulletin 133, "A Few Orchard Plant Lice," by C. P. Gillette and E. P. Taylor, and is prepared to give the most important information needed by fruit growers. Bulletin 133 gives a much fuller account of the plant lice, and is illustrated by colored plates of some of the most important species. The technical matter, and that which does not relate to the economical side is omitted from this edition, which is intended to meet the needs of most people.

Bulletin 133 will be sent on request made to the Director.

## ANTS AND HONEY DEW

Wherever the aphids are abundant, it is usually true that ants may be seen running over the infested tree or plant. It is often thought by the orchardist or farmer that the ants are present to destroy the lice, but this is probably never the case. Nearly all plant lice excrete from their bodies a sweet liquid known as "honey dew." This liquid, gathering upon the leaves of the plants, cause them to be shiny and sticky as if they had been varnished. The ants are very fond of this liquid and visit the lice to obtain it, and are always very careful not to injure the plant lice themselves.

## NATURAL REMEDIES

The plant lice are greatly lessened in numbers every year by insect enemies. Most important among these are the "lady-beetles," the "syrphus flies," and the "lace-wing flies" or "aphis-lions." Wherever these are found upon the infested plants they should be carefully protected as they often destroy the lice so completely that it is not necessary to make any application to kill the lice artificially.

## REMEDIES

The most common remedies for the destruction of plant lice are kerosene emulsion, tobacco decoctions, or soapy preparations. An insecticide that will destroy one plant louse will usually be effectual in destroying any other, if a thorough application is made.

Plant lice fly so freely from one orchard to another that it is very important that all of the orchardists in a community spray their trees whenever the lice are abundant. If one man should fail to do this, the plant lice leaving his trees, would in nearly every case, be sufficient to thoroughly colonize all of the orchards near him. Co-operation then is very important in any campaign against plant lice.

## APPLE PLANT LICE.

WOOLLY APPLE APHIS. (*Schizoneura lanigera* Hausm.)

This is probably the most serious apple pest in Colorado. It is a bark feeder, and it attacks both the roots, the trunk and the limbs of the trees, but does not feed upon the fruit or foliage. This louse is readily recognized on account of its being covered with a white woolly secretion which has suggested its common name. Upon the trunk and branches the lice attack either the tender bark about the scars or the bark of tender new shoots. Below ground, the lice attack the bark of the smaller roots causing warty swellings upon them. If very abundant, the roots are often completely covered with these smooth wart-like growths which sometimes cause the roots to die and rot off. When very abundant upon the very rapidly growing twigs, these lice often produce abrupt swellings due to the thickening of the inner bark. Sometimes these swollen portions of the limbs crack open lengthwise and the limbs may be sufficiently injured to cause them to die. Severest injury is done to the tops where there is the tenderest and most rapid growth as in grafts and water sprouts.

## LIFE HABITS

The life habits of this insect may be briefly stated as follows: Early in the spring there will be a few living lice in protected places beneath the bark or under the dead bodies of the lice that were killed the previous fall. There will also be a large number of lice living over upon the roots of the tree beneath the surface of the ground. The lice that live over on top are all very small. Those living over upon the roots are of all sizes from the smallest to those that are fully grown. By the time that the buds begin to open in the spring, the lice that live over on top will locate on tender new bark and insert their beaks and begin to suck the sap of the tree and to grow in size. At the same time a greater or less number of small lice that live over winter about the crown of the trees, and perhaps some that came up from the roots, migrate to the top and begin to feed and grow. These lice start the round of development for the year on the tree tops. They are usually first detected by the fruit grower when the little lice have grown enough to secrete a white covering to their bodies which makes them appear like little mouldy spots upon the bark. These lice increase very rapidly in number so that by the middle of June or first of July the tree may be very badly infested and the cottony secretion may be so heavy as to hang down and even fall from the bodies of the lice.

The lice are all wingless until about the first of September when an occasional winged louse may usually be found upon the trees. These lice leave the trees where they develop and fly to others. Each of these winged lice gives birth to about four or five males and as many females. Before winter comes on, each female deposits a single egg and dies. No one seems to have followed this part of the life history of the woolly aphid in the orchard. It is supposed that these eggs hatch the following spring and start new colonies.

Upon the roots of the trees the woolly aphid lives in large numbers the year around, the only difference in the winter being that the lice reproduce very slowly, so do not increase much in numbers. The cold weather seems never to be sufficient to kill them even in our coldest climates where the apple is grown.

## PREVENTION

Prevention is nearly always better than the cure. Great care should be taken therefore, when setting out a new orchard, to prevent the introduction of this louse. Orchards are usually infested by the lice that are upon the roots of the nursery trees when they are set out. All nursery stock should be thoroughly disinfected either by fumigation with hydrocyanic acid gas, or by very thorough spraying of the trees, both roots and branches, before they are set, with one of the remedies mentioned below for spraying tops.

One method of preventing injuries from this louse is to have all apple trees upon Northern Spy roots, as Northern Spy seems never to be seriously attacked by this insect.

If nursery stock is received with roots "puddled," covered with mud, the purchaser should insist upon this mud being thoroughly washed off, and the roots treated for woolly aphid, as this is one of the methods that the nursery man has of covering up woolly aphid upon his nursery stock.

To prevent the spread of the woolly aphid from tree to tree and orchard to orchard, the lice should be well cleaned out of the orchard before the first week of September as it is about this time when the winged lice begin to fly about to spread the species.

#### REMEDIES ABOVE GROUND

Wherever this louse can be reached by sprays it may be destroyed like other plant lice, but one precaution is necessary, the spray must be applied with sufficient force to remove or penetrate the woolly covering. There are several spray materials that we have found entirely successful when thoroughly applied to this insect.

*Kerosene Emulsion*—According to our experience, a good kerosene emulsion has no superior for the destruction of this insect. It seems to penetrate the woolly covering rather better than most other insecticides. When used in the ordinary strength (1/15 oil) we have always found it efficient. In the proportion of one-twentieth oil (5%), we have usually found it sufficiently strong if applied with a good deal of force and thoroughness.

Directions for preparing kerosene emulsion are given on a later page.

To be most successful, apply as a moderately coarse spray and with a pressure, if possible, of one hundred forty to one hundred eighty pounds.

*Scalecide and Other Miscible Oils*—There are upon the market a number of so-called miscible oils which, when put into water, break up at once into very fine particles forming a milky white emulsion. These oils we have found fairly successful. Two to three gallons are used in each one hundred gallons of water. After being prepared, if these oils separate out so as to form an oily film upon the surface of the water, they should not be used.

*Soaps*—We have found the standard whale-oil soaps such as "Good's Whale Oil Soap" and "Bowker's Tree Soap" quite effectual for the destruction of this louse when used in the proportion of one pound of soap to each six or eight gallons of water.

*Black Leaf*—The Kentucky Tobacco Product Co., of Louisville, Kentucky, manufacture a tobacco extract which they sell under the above trade name and which has become very popular among the orchardists of Delta County, Colorado, as a spray for orchard plant lice. We have tested it quite thoroughly and have found it very efficient for the woolly aphid if used in the proportion of one gallon of the Black Leaf in sixty-five to seventy gallons of water. In fact, we have usually been successful when using Black Leaf as weak as one gallon to one hundred gallons of water. This strength, however, requires very thorough application. It would be a good plan for any one to treat a few trees with varying strengths of this or any other insecticide for the destruction of lice a day or two before taking up his general spraying work, for the purpose of determining whether or not the strength that he contemplates using is sufficient to kill the lice. In this way he may save many dollars, from using the insecticides in a strength that will not do the work or in a proportion unnecessarily strong.

*Tobacco Decoction*—If any prefer to make their own tobacco decoctions, they may use tobacco stems or tobacco dust or whole-leaf to-

bacco. Fruit men, however, have not reported very uniform results from their own preparations. This may be due to adulterations in the tobacco or from different methods of preparing the decoction. For the preparation of tobacco decoctions see under Preparation of Insecticides, below.

It might be advisable for one who has very much spraying to do to grow his own tobacco. Mr. W. S. Coburn, President of the Colorado State Board of Horticulture, tells us that he has had excellent success using tobacco of his own raising. He uses the whole leaf and makes a decoction using one pound of tobacco for each six gallons of water. The tobacco is steeped for at least one hour, and then applied warm.

*Lime-Sulfur Sprays*—The lime-sulfur sprays have not been successful in destroying the woolly aphid during the summer season when the body is covered with the woolly secretion. It has been fairly successful when applied two or three weeks before the buds open for the destruction of the little lice that live over winter upon the trees and which do not have their bodies protected by the secretion.

#### LATE WINTER OR EARLY SPRING APPLICATIONS

So far, the remedies mentioned have been for summer treatments, when the bodies of the lice are more or less covered with the waxy secretion. We believe the best time to get results in the treatment of this louse is late in the winter or early in spring before the buds open. This is not because the lice get protection from the opening buds, but because by the time the buds have opened, the lice have their bodies more or less covered by the waxy secretions that protect them to some extent from the effects of the insecticides.

Orchards in the Grand Valley treated early in the spring of 1907 for the destruction of the eggs of the green apple aphid were also largely freed from the woolly aphid. The insecticides that were found successful in the destruction of these little over-winter lice were:

Lime 15 pounds, sulfur 15 pounds, water 30 gallons.

Lime 15 pounds, sulfur 15 pounds, water 45 gallons.

Rex lime-sulfur 1 gal., water 7 gal., lump lime 2 lbs.

Lime 15 pounds, sulfur 15 pounds and water 60 gallons was a little weak and did not give results that were fully satisfactory, and the same was true of Rex 1 gallon, water 7 gallons, without the addition of lime.

We have no doubt but what the kerosene emulsion, the soluble oil sprays, the tobacco sprays and the whale-oil soaps mentioned above could also be used successfully as early spring sprays for the destruction of the over-winter lice upon the tree tops, though we have not tested them in that way. As they are not as successful for the destruction of the eggs of the green apple aphid, and as the orchardist is likely to want to destroy both of these lice at the same time if possible, it is probable that the lime-sulfur sprays will become most popular for early spring applications.

To get best results on the woolly aphid the spring application should be made fully a week or ten days before the apple buds begin to open at all, and the trunk and crown of the tree should be thoroughly drenched. Then as a final act for best results, put Tanglefoot bands about the trunks of the

trees so that the lice at the roots can not migrate to the top. For the application of these bands see next paragraph.

#### TANGLEFOOT BANDS

In the experiments upon the Western Slope in particular, large numbers of Tanglefoot bands have been used. This material is put out by the O. & W. Thum Co., Grand Rapids, Michigan and is the sticky material put upon the Tanglefoot Fly-Paper. When at all abundant upon the trees, the newly born lice are much inclined to travel about and it is often astonishing to see the number of lice that will be captured in these bands. On the 7th of June, 1907, it was estimated that bands that had been on since the preceding fall had as many as 100,000 lice each in many cases. The bands remain fresh for several months and may be quickly freshened by rubbing a paddle over them, when they become filled with insects and dirt.

Apparently these bands do no harm to trees, but what their effect might be when continued for years we are unable to say.\* In most instances we have put them directly upon the bark but it would be safer, so far as any possible injury to the tree is concerned, to put a band of stout paper around the trunk and then put the Tanglefoot upon that. To make certain that no lice should pass under the band, a light band of the cheapest cotton batting under the paper would be advisable. This band, in connection with the spring spraying mentioned above, we believe to be the surest method of freeing the tree tops of woolly aphids.

#### MOUNDING AND CULTIVATING

The woolly aphid is not a burrowing insect in any true sense of the word. The lice that come down the trees get into the ground by way of the cracks or other openings in the soil that are large enough to allow them to enter. The lice that sometimes infest distant roots do not get to them by crawling there all the way from the crown of the tree but they get down to them directly from the surface above. So far as possible, the descending over-winter lice congregate about the crown of the tree where they are able to get below the surface in the large cracks between the trunk and the earth. The migration both to and from the roots can be somewhat, often very largely, prevented by cultivating the surface of the soil and by stirring and compacting and even slightly mounding the earth about the crown of the tree and by re-stirring this earth when it becomes compact after a rain or an irrigation.

#### TRIMMINGS

When the lice become very abundant upon water sprouts and suckers, something can be done to lessen the number by thoroughly cutting out these growths. A thorough thinning of the top so that plenty of sunlight can enter has been noticed to lessen the number of lice which find the most congenial locations for their development in dense shade and upon the north side of the limbs, at least in sunny Colorado.

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\*Mr. Geo. P. Weldon, reports, from recent observations upon the Western Slope in Colorado, rather severe injuries from the application of Tanglefoot bands that have been directly upon the bark for a year or more.



## TREATMENT BELOW GROUND

The treatment below ground is all aimed at the lice that are within three feet of the crown of the tree and within one foot of the surface. It should also be remembered that the same substances that will kill the lice above ground will also kill them below ground if they can only be put in contact with the lice, and then the orchardist should be cautious not to accumulate in the soil about the crowns of his trees substances that are likely either presently or after years of repetition, to do his trees an injury.

## EXPERIMENTS IN GRAND VALLEY

A rather extensive series of experiments for the purpose of testing substances that seemed to offer some promise of good results were carried through in irrigated orchards of the Grand Valley in Colorado, a summary of which is given below.

## THE APPLICATIONS AND THEIR RESULTS

The experiments were begun in the fall of 1906 and the winter following. The materials used upon the roots were Kerosene Emulsion, Scalecide, Chloroleum, Black Leaf Dip, tobacco dust, tobacco dust decoction, tobacco stems, tobacco stem decoction, quick lime, lime-sulfur mixture, Rex lime-sulfur, whale-oil soap, and carbon bisulfid.

Before making the applications the earth was removed over the main roots to a depth of about 6 inches, and for a distance of about 2 feet upon all sides, of each tree. One man on an average would expose the roots of about 100 trees a day. Into these dirt basins which varied some in depth and diameter with the size and depth of the roots of the trees, the liquids were forcefully sprayed so as to well drench the exposed portions. And when the liquid had nearly or quite soaked into the ground the basin was filled again and the earth banked well about the trees. In hard compact soils it is best to irrigate a few days prior to making the treatment so as to loosen the soil, and lessen the labor of excavating about the trees.

Summing up the results to September, 1907, it may be said, that practically all strengths of kerosene emulsion (3% to 50%), killed the lice well when the roots had been well treated. Where less than 6% of oil was used, the odor of kerosene soon disappeared and reinfestation soon took place by the lice that migrated downward from the top. Where, 7, 10, and 15% of oil was used the effect was still more lasting; and the 20, 33 and 50% treatments gave practically perfect freedom from lice about the crown and roots throughout the season.

A later examination was made by Mr. George P. Weldon, 1908. Mr. Weldon found the woolly aphis about equally abundant upon the treated and untreated trees in all of the blocks. Even those that were treated with 50% kerosene emulsion were badly infested upon the roots at the time that he made his examination. So we have to conclude that any treatment for the destruction of the woolly aphis upon the roots is only of temporary value. But the stronger preparations do repel the lice for a short period of time, perhaps two or three months. Mr. Weldon also found that where the 50% emulsion was used the trees appeared to be seriously affected and

probably would not live through another year. None of the weaker preparations seem to have done any injury to the trees.

#### CONCLUSIONS AS TO BEST METHODS OF TREATMENT

Just before the buds open in the spring, spray very thoroughly with a 7% kerosene emulsion, a 1 to 60 Black Leaf Dip (or some other strong tobacco decoction), or a good whale-oil soap, 1-lb to 6 gallons of water. Spray the entire trunk and also the ground about the crown of the tree at the same time. Immediately after treatment apply a Tanglefoot band over cotton so as to prevent the upward migration. If the lice become very numerous at any time upon the tops, spray them forcefully with the 7% emulsion, or Black Leaf, 1 part in 70 parts of water.

Root treatments are temporary in their effects. When the roots become very badly infested, treat as above described with 10% kerosene emulsion, Black Leaf Dip (1 to 50), 2 to 3 gallons to a tree, or if the soil is quite open and porous, carbon bisulfid.\*

#### CARBON BISULFID

This insecticide has often been reported successful against this insect.

A splendid opportunity was afforded to observe its results in the 20 acre orchard of Mr. F. D. Barney, where about 200 pounds of the liquid was used on 12-year-old apple trees. The treatment was begun on April 11, 1907, and was continued several weeks from this date.

A shovel was thrust deeply into the ground about 18 inches to two feet from the base of the tree with the blade broadcast to the tree. The handle was then tipped forward and the carbon bisulfid poured into the bottom and at the center of the opening at the back of the shovel. The shovel was then withdrawn and the earth packed upon the spot treated. The liquid was not poured directly upon the roots. From three to six holes were treated in this way about each tree and about three ounces of the liquid used. At this rate the cost of the material did not amount to as much as three cents per tree.

#### TOBACCO DUST AND STEMS

Dry tobacco in the form of tobacco dust or tobacco stems or even the whole leaf tobacco when used freely about the trees has not given very satisfactory results. Apparently these substances are of no use unless the tobacco is thoroughly wet, as soon as it has been placed about the roots, so that the juices will penetrate the soil and kill the lice. In a few instances orchardists have reported very satisfactory results but in nearly all cases they have reported failure. We believe if tobacco is used at all against this insect upon the roots of trees the best method is to apply it in the form of a strong decoction.

Prepare as for a top spray and use two or three gallons about each tree as in case of kerosene emulsion as described above. The tobacco does not have as lasting an effect apparently as does the emulsion.

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\*Carbon bisulfid may be procured in quantity from Edward R. Taylor, Penn Yan, New York.

Tobacco decoction in which two pounds of stems, or dust, or one pound of whole leaf tobacco was used to each three gallons of water and forcefully sprayed upon the exposed roots gave fairly good results but these were not equal in their killing and repelling effects to a 10 to 15% kerosene emulsion.

*Black Leaf Dip* used in the proportion of 1 gallon in 65 gallons of water gave results similar to the preceding.

*Scalecide* used 1 to 40, 1 to 50 and 1 to 60 in water killed the lice fairly well but had very little repelling effect afterwards.

*Lump Lime* applied in a manner similar to that employed with the tobacco stems, 10 to 20 pounds to a tree, was of little or no benefit.

*Soaps* used for root treatment were of doubtful benefit.

Some Wholly Unsuccessful Substances were, "Chloroleum" potash lye, wood ashes, salt, and flooding with water for several hours.

### THE GREEN APPLE APHIS. (*Aphis pomi* DeGeer.)

This is the common green louse curling the leaves of the apple tree in Colorado. While primarily a leaf feeder this louse also attacks the tender tips of growing shoots, especially grafts and water sprouts. This insect ranks close to the woolly aphid in extent of injuries to the apple trees. It also attacks the pear, the thorn and the quince quite freely.

#### LIFE HISTORY

This louse remains upon the apple, or closely allied trees, throughout the year and does not go upon other trees or vegetables.

The first lice in the spring hatch from eggs that were deposited the previous fall upon the twigs of the trees. These first lice hatch a few days before the buds open and are ready to insert their sharp beaks into the first tender green tissue of the opening buds. These lice are all females and become fully grown in about two or three weeks, when they begin giving birth to living young. From this time on the lice increase very rapidly if they are not kept down by their natural enemies or the insecticides of the orchardist.

At first all the lice are wingless, but by the 10th to the 15th of May in the warmer portions of the state, and about two weeks later in the cooler orchard sections, the winged lice begin to appear and to fly from tree to tree and orchard to orchard with the prevailing winds. About the first week in September little brown wingless males and green wingless egg-laying females will appear, and a little later the females will begin laying green eggs that soon turn black upon the apple twigs. The freezing nights in November or early December kill all the lice and the eggs live over to hatch the following spring.

#### REMEDIES

Treatment for this insect may be for the destruction of the eggs and young lice before the buds open in the spring, or for the destruction of the lice upon the leaves during the growing season.

#### TO DESTROY THE EGGS

*Kerosene Emulsion* in all our experiments has proven useless

for the destruction of the eggs except when applied so strong as to make it entirely impractical to use it.

*The Lime-Sulfur Mixtures*—Either the 1-1-2, or the 1-1-3 formula or Rex lime-sulfur in dilutions down to 1 gallon in 8 gallons of water, have given good results. Lime-sulfur by the 1-1-4 formula is a little weak for good results.

*Black Leaf*—This preparation used in the proportion of 1 gallon in 25, and 1 gallon in 33 of water gave good results, but 1 gallon in 40 gallons of water was not very satisfactory, many of the eggs hatching.

#### SUMMER SPRAYING

For the destruction of the lice upon the leaves spray very thoroughly and forcefully from all directions with kerosene emulsion, 5 to 7 per cent. oil; Black Leaf, 1 part in 70 parts of water; or one of the other plant louse sprays discussed at the close of this bulletin, remembering that **thorough and forceful applications** are necessary in order to get best results.

### PEACH PLANT LICE.

There are two species of plant lice attacking peach trees in Colorado, the Green Peach Aphis (*Myzus persicae* Sulz.) and the Black Peach Aphis (*Aphis persicae-niger* Smith.) The former is very generally distributed and occurs nearly every where that this fruit is grown, while the latter occurs in isolated orchards only, and might be kept down so as to do no appreciable harm, and it is quite possible that it might be practical to exterminate it from the state.

#### THE GREEN PEACH APHIS

Is distinguished by its pale green, or greenish yellow color in the wingless forms and the winged lice have the same general ground color to their bodies with more or less of black markings above.

The lice appear very early in the spring and often attack the blossoms, and the young peaches when the latter first form, causing them to wilt and drop. Later it attacks the leaves causing them to curl and turn yellow. By the middle of the summer this louse leaves the peach trees and goes to cabbages, turnips, radishes, tomatoes, potatoes and many other growing crops, as well as many of the common weeds. The lice remain upon these plants during the summer and in the fall there are winged forms that return to the peach to give birth to true males and females, the latter of which deposit the eggs that remain upon the twigs of the trees during winter to hatch out the early lice of the following spring.

#### REMEDIES

Spray thoroughly with kerosene emulsion, Black Leaf (1 part in 60 of water), or a solution of whale-oil soap (1 pound to 6 gallons of water), about three or four days before the blossoms open. Then, if the lice appear later, treat as in case of the green apple aphid.

#### THE BLACK PEACH APHIS

This louse is readily distinguished from any other attacking the peach

by its black color when fully grown, whether winged or wingless. The immature lice are of a yellow or amber color. In all stages, and especially in the spring, this louse will be found upon the bark of the small limbs where it continues to feed after the leaves appear. Many of the lice will go upon the leaves also causing them to curl.

Like the preceding species, this louse also disappears by the middle of July or the first of August without anything being done for it, but it does not go to any other plants so far as known, but is said to descend to the roots of the peach where it remains until the following spring. So far as known this species does not lay eggs but lives over winter as a louse.

This insect is continually being shipped into Colorado upon the roots of nursery stock. Our Horticultural law and the vigilance of our county horticultural inspectors has done much to keep it out of the orchards, but it is impossible, under present methods, to prevent an occasional tree, infested with this louse, being planted.

#### REMEDIES

All peach trees, before being planted, should be thoroughly fumigated, or dipped or sprayed with Black Leaf, a home-made tobacco decoction, or a good kerosene emulsion.

The remedies in the orchard are the same as for the Green Peach Aphis mentioned above.

### PLUM PLANT LICE.

#### THE MEALY PLUM LOUSE. (*Hyalopterus arundinis* Fab.)

A light green louse with a rather long narrow body that is covered with a fine white powder. The lice occur upon the under side of the leaves, which they may completely cover by the middle of June, but the leaves do not curl. By the first week in July, many of the lice are winged, and by the last of that month the lice will nearly all have left the plum. The lice go to certain grasses, especially the large coarse Reed-grass growing in wet places. In the fall winged migrants return to the plum where, later, the eggs are deposited by egg-laying females and the lice all die. The next spring the eggs hatch to continue the species.

#### REMEDIES

Spray as for the green peach aphis, but use a heavy pressure and direct all of the spray upon the under side of the leaves where all the lice are. These lice are killed with difficulty on account of the powdery covering upon their bodies.

#### THE RUSTY PLUM LOUSE. (*Aphis setariae* Thos.)

This louse is readily distinguished from all others upon the plum by its dark brown body color, and with a hand lens one can usually see the conspicuous white legs, antennae and tail. This louse seems to have a preference for the tender bark near the tips of rapidly growing shoots although it covers the undersides of the leaves also. At a little distance the louse may almost appear black to the naked eye. This louse spends the entire

year upon the plum, though it is known to attack barn grass *Echinochloa Crus-galli*.

The remedies for this louse are exactly the same as for the green peach aphid already mentioned.

#### THE BLACK CHERRY LOUSE. (*Myzus cerasi* Fab.)

This louse has long been known in Europe as a pest upon cherry trees. It is generally distributed throughout the cherry growing districts of the eastern slope in Colorado, but as yet only occurs in isolated orchards upon the western slope.

Those having cherry trees should make a vigorous attempt to exterminate this louse as soon as it is noticed in the cherry orchards. It could not be mistaken for any other insect upon the cherry tree as it is deep black in color and infests the under side of the leaves and the bark of the tender new growth. It is usually accompanied by ants in abundance. This insect remains upon the cherry, and so far as known, does not migrate to any other plant. On account of its numerous insect enemies it is likely to almost disappear for a time during the middle of the summer, but may continue quite abundant throughout the season. The last brood in the fall lay eggs which carry the species over winter to hatch in the spring.

The remedies are exactly the same as for the foregoing species.

#### THE HOP PLANT LOUSE. (*Phorodon humuli*.)

This is the green louse that has caused such severe losses in hop vineyards. The hop is the summer food-plant and in the fall winged hop lice migrate to the plum trees where the egg-laying females later deposit eggs upon the branches which hatch the following spring. These lice are very similar to the preceding in general appearance but lack the heavy covering of powder. While most of the lice leave the trees for the hop before the middle of July, we have found some of the lice remaining throughout the summer on plum leaves.

#### REMEDIES

The same as for the green peach aphid.

#### PREPARATION OF A FEW IMPORTANT PLANT LOUSE INSECTICIDES

*Kerosene Emulsion*—Prepare in the following proportions:

Soap one half pound.

Water one gallon.

Kerosene two gallons.

To prepare, dissolve one half pound of soap in one gallon of soft water by boiling; when well dissolved and still boiling hot, remove from the fire and add two gallons of kerosene, and agitate at once as briskly as possible. If large quantities are being made, a good way to emulsify is to use a force pump and spraying nozzle and pump the mixture as forcefully as possible back into the vessel containing it. If the emulsion is properly formed, the whole mass will appear much like whipped cream and will mix readily in water without a film of oil rising to the top. Sometimes, when

the oil is rather cold, it lowers the temperature so much that a good emulsion is not obtained. In this case the dish may be placed back over the fire and the mixture heated to the boiling point when it must be again removed and agitated to form the emulsion. In case the mixture of soapy water and kerosene is placed over the fire, it must be watched every moment to see that it does not quickly boil over and take fire. As soon as emulsified, add twenty-seven gallons of water and use at once. This will make thirty gallons of the mixture, and such an emulsion will be one-fifteenth oil (or a 7% emulsion). This is the strength ordinarily used for the destruction of insects upon plants. For larger or smaller quantities, prepare in the same proportions.

Sometimes the emulsion is not perfect and a little oil rises to the top. In such cases, if the last in the barrel or tank is pumped out upon the foliage, it is likely to burn it. So it is advisable, unless the emulsion is of good quality, to throw out the last few gallons making no use of it.

It is best to dilute and apply kerosene emulsion as soon as it is prepared.

Avoid using alkali or any hard water in making the emulsion, as it will cause the oil to separate and rise to the top. Any clean soft water will usually give good results.

If a stronger emulsion is to be used, prepare as above, but do not use as much water in making the dilution. For example, if 17 gallons of water were added in place of 27 to dilute the emulsion, it would be one-tenth oil or a ten per cent. emulsion, and if 37 gallons were added, it would be a five per cent. emulsion.

Those who have trouble in making kerosene emulsion can procure a commercial article known as "Aphicide" manufactured at Grand Junction, or else use one of the tobacco preparations instead.

#### *Tobacco Decoction—*

Tobacco stems or tobacco dust two pounds.

Water four gallons.

Put the tobacco in the water, enough to cover, which may be either cold or hot. Place over the fire and when the water has reached the boiling point, remove some of the fire and allow the water to simply simmer for fully one hour, when the liquid is ready to be drained off, diluted to the above proportions and applied.\*

If whole-leaf tobacco is used, prepare as above using one pound of tobacco to each four gallons of water.

No lime or other alkaline substances should be added to the tobacco while cooking. Apply at once, or within a few days after making if possible.

*Black Leaf*—There is nothing to do in the preparation of Black Leaf except to thoroughly stir the contents of the can before pouring out any quantity for dilution. In most cases one gallon of the Black Leaf will be found sufficient for each seventy gallons of water. But if in the treatment of any louse this does not seem sufficient it may be used in proportion

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\*Dr. W. P. Headden, Chemist of the Experiment Station, has proven that the nicotine is rapidly driven off by boiling, and especially where the water is strongly alkaline.

of one gallon to sixty or sixty-five gallons of water. We have usually succeeded in killing plant lice with this preparation in the proportion of one gallon to each one hundred gallons of water. Thoroughness of application is of as much importance as the strength of the material used.

If this substance is not obtainable in your home town it may be procured from the Watkins Merchandise Co., Denver, or The Kentucky Tobacco Product Co., Louisville, Kentucky.

*Miscible Oils*—There are several miscible oils upon the market which may be added directly to water forming a milky emulsion at once. In the preparation of any of these, such as "Scalecide," or "Target Brand Scale Destroyer" or "Killo-scale," add the oil directly to the water with a little stirring. One gallon of the miscible oil in 30 to 50 gallons of water will make a mixture which in most cases will be strong enough to kill plant lice, if thoroughly applied.

*Lime-Sulfur Mixture*—(For winter spray only.)

Flowers of sulfur, fifteen pounds.

Good lump lime, fifteen pounds.

Water, forty-five gallons.

This is the 1-1-3 lime-sulfur mixture. First slake the lump lime with sufficient warm water, and while still boiling hot add the sulfur and stir it in. Place over fire and continue the boiling, adding water when necessary, until the mixture changes to a deep reddish brown color which indicates that the lime has cut the sulfur. It will be necessary to boil steadily for about forty minutes to one hour to produce this result. The mixture should then be diluted to form forty-five gallons of the spray, and should be applied at once.

When the lime-sulfur mixture is placed in the barrel or tank it should be strained to take out all lumps that would clog the spray nozzle. If allowed to stand for any great length of time after being prepared, the lime-sulfur crystalizes out to a considerable extent. In such a case it is necessary to heat the mixture again before applying so as to dissolve all the crystals. If the crystals are re-dissolved the mixture will be as strong as before.

To make 1-1-2 lime sulfur mixture, prepare as above using only thirty gallons of water for the fifteen pounds of lime and the fifteen pounds of sulfur.

For the 1-1-4 lime-sulfur mixture prepare in the same manner, but dilute to sixty gallons before applying.

*Rex Lime-Sulfur*—We have found the Rex lime-sulfur in the proportion of one gallon of the Rex to seven or eight gallons of water to be just about equal in effect to the 1-1-3 home made lime-sulfur preparation. Rex lime-sulfur solution can be made white by the addition of lime at the rate of 5 to 10 pounds for each 50 gallons of spray.

*Whale-Oil or Fish-Oil Soaps*—The so-called whale-oil or fish-oil soaps which are quite extensively used for the destruction of plant lice, will usually be effective if thoroughly applied in the proportion of one pound of the soap to each six to eight gallons of water. There are numerous brands of these soaps upon the market. Those that we have used quite successfully are Good's Whale-Oil Soap and Bowker's Tree Soap.



EXPERIMENTS FOR THE DESTRUCTION OF THE WOOLY APPLE APHIS

ORCHARD OF	INSECTICIDES	STRENGTH	TREATED	DATE USED	EXAMINED
P. Nissen	Lime and Sulfur	15, 15, 50	Tops and Roots	November 7, 1906	Nov. 19, '06 Nov. 23, '06 Nov. 28, '06
	Chloroleum	1 to 40	Tops		
	Scalecide	1 to 50	Tops and Roots		
	Tobacco Dust	5% oil	Roots	Nov. 23-28, 1906	Jan. 11, '07 Mar. 15, '07 Mar. 25, '07 June 6, '07
	Tobacco Stems	2, 4, 5, 6 and 8 lbs.			
	Quick Lime	2, 4, 5, 6 and 8 lbs.			
	Rex	10 and 20 lbs.			
	Ker. Emulsion	1 to 11	Tops	Mar. 25, '07	
	Tanglefoot	7% oil	As Bands		
	D. Smith	Ker. Emulsion	22.2% oil	Tops	December 18, 1906
" "		16.6% oil	"		
" "		13.3% oil	"	June as bands	
Scalecide		1 to 19 (5%)	"		
E. Turpen	Rex L. S.	1 to 8 with lime	Tops	March 2-22, 1907	April 26, 1907
	Adams L. S.	1 to 8 with no lime	"		
	Lime and Sulfur	1-1-2	"		
	" "	1-1-3	"		
M. Cheedle	" "	1-1-4	"		
	Rex L. S.	1 to 8 no lime	Tops	March, 1907	June 5, '07
	Tobacco stem Decoction	1 lb. to 1 gal.	"	Apr. 2-6, '07	Aug. 22, '07 June 5, '07 Aug. 22, '07
C. Jaquette	Ker. Emulsion	7% oil	"	Mar. 1 to Apr. 6	
	Whale-oil Soap	1 lb.-4 gal.	Tops	April 2	April 9 to June 7 June 20 May 16
Ker. Emulsion	9.4% oil	"	April 2		
Ker. Emulsion	6% oil	Roots and Tops	April 9		
Ker. Emulsion	6% oil	Roots	June 7		
Checks		"	April 11		
Carbon Bisulfid	3 oz. to tree	"			
A. Smith	Lime Sulfur		Tops		
	Rex & Adams		"		
	Tobacco Dust Decoction	1 lb.-2 gall.	"		
	Tobacco Dust Decoction	1 lb.-3 gall.	"		
	Ker. Emulsion	5% oil	"	Mar. 2 to 6	Mar. & May
	" "	6% oil	"	Mar. 2 to 6	" "
Cornetto	" "	7% oil	"	May	
	Ker. Emulsion	3, 5, 6, 7, 10, 15, 20, 33, and 50% oil	Roots	June 26 to July 2	July 22
	" "	5 and 6% oil	Tops		
	Black Leaf	1 to 50	Roots		
	" "	1 to 66	"		
	" "	1 to 75	"		
	Tobacco Dust	1 lb. to 1 gal., 1 lb. to 3 gal., 1 lb. to 5	"		
	Tobacco Stems	2 lbs.-1 gal.	Roots		August 22 and Sept. 13
	" "	1 lb.-1 gal.			
	" "	1 lb.-3 gal.			
" "	1 lb.-5 gal.				
Tobacco Stems	6 lbs. per tree	Roots			
Scalecide	1-40, 1-60, 1-50	Roots			

ground, the basin was filled again and the earth banked well about the trees. In hard, compact soils it is best to irrigate a few days prior to making the treatment so as to loosen the soil and lessen the labor of excavating about the trees.

Summing up the results to September, 1907, it may be said, that practically all strengths of kerosene emulsion (3 per cent. to 50 per cent.), killed the lice well when the roots had been well treated. Where less than 6 per cent. of oil was used, the odor of kerosene soon disappeared and reinfestation soon took place by the lice that migrated downward from the top. Where 7, 10 or 15 per cent. of oil was used, the effect was still more lasting, and the 20, 33 and 50 per cent. treatments gave practically perfect freedom from lice about the crown and roots throughout the season.

The trees in the above experiment were examined later by Mr. George P. Weldon, who reported upon the effects of the various applications, as follows:

#### EXPERIMENTS IN THE ORCHARD OF J. CORNETTO.

"Grand Junction, Colorado, July 10-11, '08.

"I am disappointed to find that the wooly aphid is very abundant on all of the roots of treated, as well as check trees, in the experiment, even where a 50 per cent. kerosene emulsion was used. Where this strength was applied, the odor of the soil is still very pronounced when the earth is stirred, and the trees show severe injury from the application. The roots are being killed and the leaves are wilting, and it is probable that the trees will soon die. A comparison of the treated trees with the check trees does not indicate that any benefit from the various treatments has continued to the present time. Even where the 50 per cent. oil was used, the lice are as abundant as upon the check trees in the experiment. There are almost no lice above ground upon any of the trees at this time. With the exception of the 50 per cent. kerosene emulsion treatment, none of the applications seem to have done any harm to the trees.

"Roots treated with tobacco dust, even where eight pounds to a tree are used, do not show any indications of benefit from the application now.

"In the Jacquette orchard I find that the Tanglefoot bands that have been on for two seasons are doing serious injury to the bark of the trees, especially upon the south side."

Some orchardists have reported to us that they believe they have had trees sickened and even killed from the kerosene emulsion that accumulated about the roots at spraying time, and one or two have reported applying kerosene emulsion to the roots of apple trees during the winter for the destruction of the woolly aphid and that the trees all died after a few years. So, while we know that kerosene emulsion is a very effectual destroying agent for woolly aphid on roots, we are inclined to advise those who use it to be cautious and to keep a close watch of their trees and stop farther treatments as soon as any signs of injury appear. It might be well to select a few trees that one does not care very much for and

treat them somewhat severely with the thought that so long as they show no injury, it is probably safe to treat others more lightly.

#### CARBON BISULFID.

This insecticide has often been reported successful against this insect upon the roots.

A splendid opportunity was afforded to observe its results in the 20-acre orchard of Mr. F. D. Barney, where about 200 pounds of the liquid was used on 12-year-old apple trees. The treatment was begun on April 11, 1907, and was continued several weeks before being completed.

At the beginning of the treatment a trench 4 or 5 inches deep was dug encircling the tree and about 3 to 4 feet in diameter. Three ounces of liquid carbon bisulfid were poured into the bottom of the trench, and moist earth thrown quickly in and packed down with the shovel. This method did not seem successful, and another process was substituted. A shovel was thrust deeply into the ground about 18 in. to 2 ft. from the base of the tree with the blade broadside to the tree. The handle was then tipped forward and the carbon bisulfid poured in at the center of the opening at the back of the shovel. The shovel was then withdrawn and the earth packed upon the spot treated. Care was taken not to pour the liquid directly upon the roots. From three to six holes were treated in this way about each tree and about three ounces of the liquid used. At this rate the cost of the material did not amount to as much as 3 cents per tree.

Observations on May 16th showed some good accomplished, especially where the infested roots had been near to the points where the bisulfid had been poured, but there were many living lice still remaining about the crowns of the trees. The soil at time of treatment was loose, friable and moist, but not wet. The results seemed to indicate that such a treatment would be profitable in cases of severe root infestation, but not as effective as kerosene emulsions or tobacco decoction applied directly to the exposed tree roots.

*Tobacco Dust and Stems* have not given very satisfactory results in our experiments nor with most of the orchardists who have tried them. Where 5 or 6 pounds to a tree has been used directly upon the exposed roots and about the crown, followed by a thorough irrigation about the trees, we have had reports of good and poor results, even when thoroughly irrigated at once to soak the juice down about the roots, so we do not think tobacco dust or stems can be relied upon for satisfactory results.

*Tobacco Decoctions* in which 2 pounds of stems, or dust, or 1 pound of whole leaf tobacco was used to each 3 gallons of water and

forcefully sprayed upon the exposed roots gave fairly good results, but these were not equal in their killing and repelling effects to a 10 or 15 per cent kerosene emulsion.

*Black Leaf Dip* used in the proportion of 1 gallon in 65 gallons of water gave results similar to the preceding.

*Scalecide* used 1 to 40, 1 to 50 and 1 to 60 in water killed the lice fairly well, but had very little repelling effect afterwards.

*Soaps* used for root treatment were of doubtful benefit.

*Some Wholly Unsuccessful Substances* were "Chloroleum," lump lime (10 to 20 pounds to a tree), potash lye, wood ashes, salt and flooding with water for several hours.

#### ROOT TREATMENT OF NURSERY STOCK

Apparently none of the inspection laws have prevented, though they have greatly lessened, the shipment of trees infested with woolly aphid. It is commonly recommended to dip or fumigate such trees to destroy the lice.

We have found the ordinary dipping process quite ineffectual in cases of severe infestations on account of the protection afforded by the woolly secretions, but we have had perfect success by untying the bundles and forcefully spraying the trees upon roots and tops with kerosene emulsion (7 to 10 per cent oil), or one of the tobacco or soap preparations used for top treatment. *Make the spray forceful and drench all parts.* It requires but little time or material to treat thousands of trees. Where this work is to be done on a large scale, a water tight spraying surface or pan could easily be arranged with a drainage tank so that the same spray material could be used over and over.

Dipping for 6 seconds in water heated to 140 degrees Far., and fumigating for 40 minutes in hydrocyanic acid gas we have also found efficient remedies for the destruction of this louse on nursery trees.

#### CONCLUSIONS AS TO BEST METHODS OF TREATMENT

Just before the buds open in the spring, spray very thoroughly with a 7 per cent kerosene emulsion, Black Leaf dip 1 pound to 60 gallons of water (or some other strong tobacco decoction), or a good whale-oil soap, 1 pound to 6 gallons of water. Spray the entire trunk and also the ground about the crown of the tree. Immediately after treatment apply a Tanglefoot band over cotton so as to prevent the upward migration. If the lice become very numerous at any time upon the tops, spray them forcefully with the 7 per cent emulsion, or Black Leaf, 1 part in 70 parts of water.

Root treatments are temporary in their effects. When the roots become very badly infested, treat as above described with 10 per cent kerosene emulsion, Black Leaf dip (1 to 50), 2 to 3 gal-

lous to a tree, or, if the soil is quite open and porous, carbon bisulfid\*.

THE GREEN APPLE APHIS  
(*Aphis pomi* DeGeer.)

Plate I, Figs. 1 to 8, and Plate III, Fig. 5.

This insect was first described in Europe by DeGeer in 1773 and two years later was described by Fabrecius as *Aphis mali*. It is not known when it first appeared in America, but Mr. Theodore Pergande has been quoted as saying that he first saw it here in 1897. In 1900 Dr. J. B. Smith gave excellent descriptions of this louse in its different forms with an account of its habits in Bull. 143 of the New Jersey Experiment Station. This seems to be the first published account of what we are calling the "green apple aphid" in this country. Now it is known to be very generally distributed throughout the country, being readily carried upon nursery stock in the egg stage.

The dry climate of Colorado seems favorable for the development of this louse and its natural enemies have not been sufficient in recent years to keep it in check without the aid of spray pumps and insecticides.

Sanderson's statement\* that *A. pomi*, "is, however, by no means as common as *A. fitchii*" (really *avenae*), surely does not apply at all to Colorado, where the latter species, in all the apple growing sections, is a comparatively rare insect and one that we have never found occurring in abundance upon a single tree. *A. pomi* is one of our very worst orchard enemies, and is, also, the species most commonly brought into the state in the egg stage, upon nursery stock.

FOOD PLANTS

This louse spends its entire life cycle upon the apple and pear trees and does not, so far as we have been able to observe, leave these trees during a portion of the summer to feed upon other plants, as so often occurs with other species. So one need never fear that this insect will migrate from the apple and pear trees to other fruits or vegetables, and it is equally true that it will not migrate to the apple and pear trees from weeds or vegetables, as it does not infest them.

Besides the apple and pear, this aphid also attacks the hawthorn, the quince and the flowering crab, but the cultivated apple seems to be its favorite food plant. Among the apple trees it has its preference. The Missouri Pippin seems to be its first choice

\* Carbon bisulfid may be procured in quantity from Edward R. Taylor, Penn Yan, New York.

\* Thirteenth Ann. Rep. Del. Ex. Sta., p. 131, 1901.

while Rome Beauty, Black Twig, Ben Davis and a few others are close seconds, and the Northern Spy is scarcely attacked at all.

This insect gets its food by inserting its beak and sucking the sap from either the leaves or the rapidly growing, softer and more tender twigs. For this reason rapidly growing young trees, grarts, and water sprouts are worst infested. When upon the foliage, this louse feeds, for the most part, upon the under side of the leaves, which curl in such a way as to give it considerable protection from the direct rays of the sun, and from sprays that are not used with force and thoroughness.

#### LIFE HISTORY

Like most insects, this green aphid has very definite life habits. Probably we cannot do better than to begin with the egg and follow it through its different stages of development.

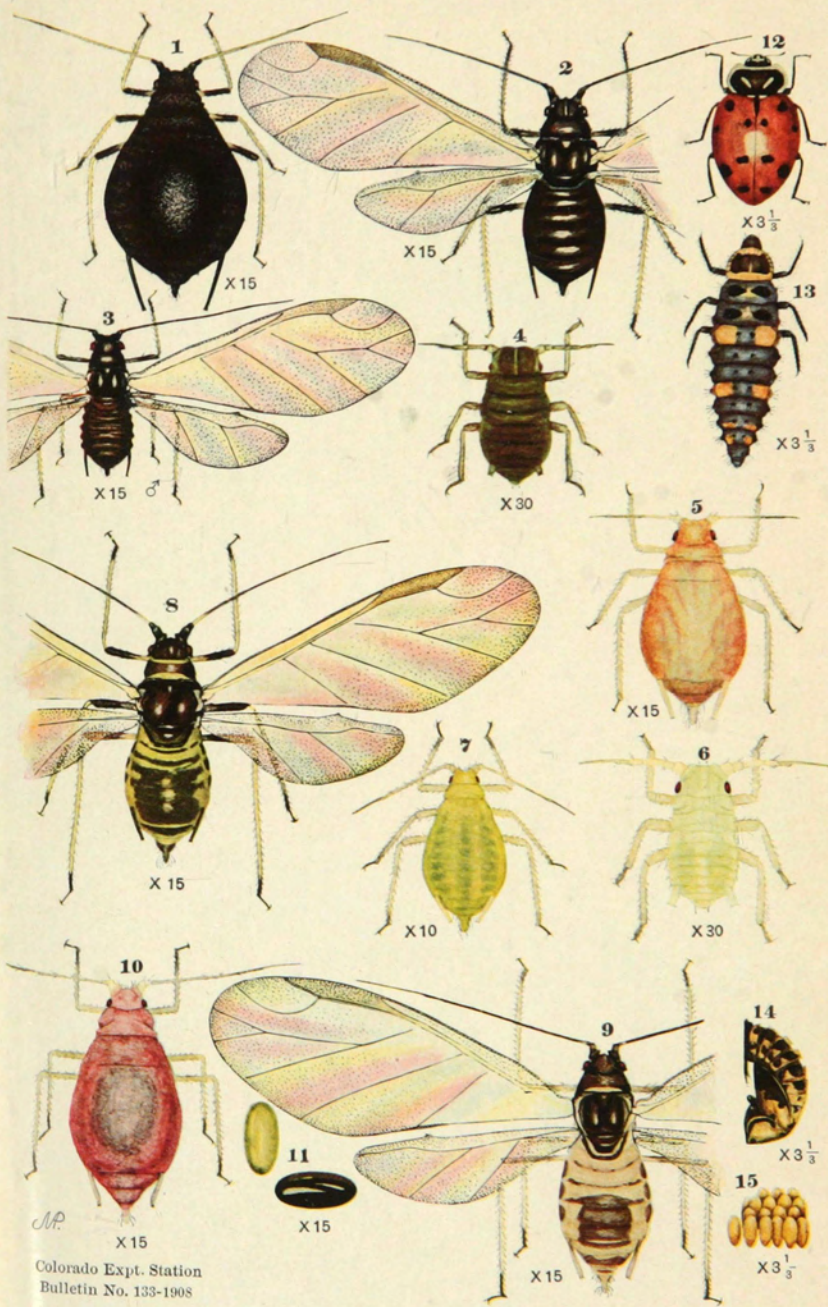
#### THE EGGS

The winter is past entirely in the egg stage upon the twigs of the trees that were infested the previous fall.

Many lice select the axils of buds and rough places in the bark for the deposition of their eggs, but this one seems to prefer the free surface of the rapidly growing shoots. When the lice are abundant, the water sprouts, in particular, are often fairly blackened with eggs (see Plate III, Figure 5).

When first deposited, the eggs are light green in color, but soon become shining black from the action of the sunlight upon them. They are long oval in shape and are just large enough to be plainly seen by one who has good eye sight. By actual measurement it would require 40 of these eggs, placed end to end, to extend one inch.

Very few of the eggs ever hatch, according to our observations. On the eastern slope, at least, it seems doubtful if more than one per cent hatch in average years. Even this small percentage of the eggs hatching is sufficient with the rapid rate of increase to enable this insect to become destructively abundant before fall. When the time arrives for the little louse to come from its winter quarters, the shell splits longitudinally upon the upper surface near one end and the prisoner, with much writhing and kicking works itself out. No definite date can be fixed for the hatching. The first lice were found emerging in 1907 at Palisades just as the first apricot blossoms were opening. At that time the apple blossoms were but little swollen. In a general way it may be said that the lice begin to hatch a little before the apple buds show any green and continue to hatch for two or three weeks, depending upon whether the weather is warm or cold most of the time.



Colorado Expt. Station  
Bulletin No. 133-1908

PLATE II

PLANT LICE

M. N. WORKS  
BUFFALO





## THE STEM MOTHERS

## Plate I, Figs. 1 and 2.

The lice hatching from the eggs in the spring are all females, and are called "stem mothers" because from them spring all the succeeding brood of the year. No other lice of the year are quite like these that come from the eggs. The little louse upon first hatching is very dark green in color while other young of the year are very light yellowish green (Plate I, Figs. 1 and 4). If the buds are not yet open, the stem mothers are able to live a few days for the buds to swell enough to enable them to insert their beaks into the tender tissue of the young leaves for their first meal. As soon as the buds open enough to make it possible, the little lice work their way down into the folds of the opening leaves where they are protected from the cold and from the lady beetles and other insect enemies and the death dealing sprays of the orchardist. In about two or three weeks, if the weather is warm, our stem-mother will have attained full development and will begin to give birth to living young at the rate of 3 or 4, to 10 or 12 a day. During their whole life these stem-mothers differ in appearance from any of the later broods of the year. They never get wings, are of a rather dark green color with a conspicuously dark colored head; the antennae are shorter and usually six, though they may be seven jointed; the cornicles are rather short and black and the cauda or tail is also black. The stem-mother is usually a little smaller than her grown children and grand children, measuring only .06 of an inch (1.50 mm.) in length when fully grown. (See Plate I, Fig. 2.)

## SECOND GENERATION

As soon as the stem mother becomes fully grown, she begins to give birth to living young which constitute the second generation. Each female may deposit as many as 75 to 100 young during a period of two or three weeks and then she dies. These young are all female which, like their parent, are capable of giving birth to living young. We have found a very small percentage of the second generation getting wings. So the winged lice may begin to scatter from tree to tree and orchard to orchard at Grand Junction about May 10th, and at Fort Collins about June 1st. It is not until the 3rd. generation that the winged lice appear in large numbers, so that the migration of winged lice is not usually noticed until about the first week in June in the warmer orchard sections in Colorado, and two or three weeks later in the colder portions. After mid summer the winged lice begin to grow fewer in numbers and disappear entirely about September 1st.

## WINGLESS FEMALE OF SUMMER GENERATIONS

## Plate I, Fig. 3.

The summer wingless females (all after the stem mother) when fully grown, are a trifle larger than the first generation, are yellowish green in color, have 7 joints to the antennae, both antennae and cornicles are longer than in the stem mother, and the cornicles, cauda and the greater portion of the antennae are black. These females continue until late fall and are very prolific, giving birth to living young.

## WINGED FEMALES

## Plate I, Fig. 5.

The winged females also give birth to living young lice. They fly about to other trees and so establish many new colonies, some of which will be likely for a time to escape being found by their enemies.

These winged migrants are not numerous until the third brood and they continue to appear in considerable numbers until about the last of August, when they soon disappear, and true sexual males and egg-laying females take their places.

About the first of September\* males and egg-laying females begin to appear. The males and females pair and the latter begin to lay eggs about the middle of September and continue to do so until killed by severe freezes.

## MALES

## Plate I, Fig. 7.

The male is wingless, is yellowish or rusty brown in color, and is much smaller than any other adult lice of the year.

## EGG-LAYING FEMALE

## Plate I, Fig. 8.

The egg-laying female is considerably larger than the male, but is smaller than the other female lice of the year and is yellowish green in general color with considerable variation.

## NATURAL ENEMIES

This louse is attacked by about the same natural enemies as the wooll aphid. The Lady Beetles seem to us to be the most efficient as destroyers of it though the syrphus flies and aphid lions (lacewing flies) also kill great numbers. They are almost never attacked by parasites, in fact the only parasitic attacks that we have seen have been by a minute Chalcid (*Alphalimus mali*)\* that causes the lice to change to a deep coal black while they retain their natural size and shape.

\* Our earliest date for males at Fort Collins is September 4.

\* Determined for me by Dr. L. O. Howard.

Sometimes the orchardist thinks that ants are destroying the lice upon his trees. This is never the case. The ants visit the lice for their sweet secretions and are careful not to harm them and they ever stand ready to drive away many of the enemies of the lice.

#### REMEDIES

The remedies to use against this insect, from the time the buds open in the spring until the leaves drop in the fall, are the same as those given for the woolly aphid above ground. Kerosene emulsions that is one-fifteenth oil and Black Leaf dip, 1 part in 70 parts of water, are the two most favored sprays at the present time in Colorado.

#### WINTER AND EARLY SPRING SPRAYS

For several reasons, late winter and early spring are most favorable for the destruction of the green apple aphid. The orchardist usually has more time than in which to do the work; the foliage being off, it requires less pains, time and material to make a thorough treatment, and by spraying early one avoids destroying the plant louse enemies which are killed along with the lice in summer spraying. If the work is well done in early spring, the trees should be free from lice until the winged migrants have flown in from neighboring orchards and established their colonies upon the trees. Such orchards will seldom become seriously infested before July, if they are at all during the summer, so they are sure to make their growth unhindered and will seldom fail to mature their crop in good condition.

Professor Aldrich seems to have been the first to report success from winter treatment of orchards for the destruction of the eggs of plant lice.\* He reported very satisfactory results from the use of lime-sulfur sprays made by both the 1-1-2 and the 1-1-4 formulas (1 lb. lime, 1 lb. sulfur, and 2 gallons water; and 1 lb. lime, 1 lb. sulfur and 4 gallons water), but did not succeed in destroying the eggs with emulsions of kerosene oil.

In our experiments for the destruction of eggs we have found the oil emulsions useless, killing only in very high strengths, if at all.

The treatments that we have found quite successful for the destruction of eggs are:

Lime-Sulfur mixture, 1-1-2 formula, sp. grav. 1065.

Lime-Sulfur mixture, 1-1-3 formula, sp. grav. 1045.

Rex Lime-Sulfur, 1-8 strength, sp. grav. 1055.

Rex Lime-Sulfur, 1-4 strength, sp. grav. 1080.

Black Leaf, 4 per cent strength.

\* Bull. 40, Idaho Exp. Sta., 1904.

Black Leaf, 3 per cent strength.

Black Leaf, 2 1-2 per cent strength (a little weak. )

#### THE CLOVER APHIS

(*Aphis bakeri* Cowen)

Plate III, Figs. 1, 2.

This louse was described by Mr. Cowen in Bull. 31 of this station in 1895. *Aphis cephalicola* Cowen, described from heads of white clover, is the same species.

On April 13, of this year we found a red stem-mother of some unknown aphid rather common, and in many cases fully grown, upon the buds of apple and pear trees about Delta, Colorado. The color varied from a dark green streaked and mottled with red to a deep dark red, with cornicles very short and pale yellow throughout. At this time the apple buds were just beginning to open and peach trees were nearly in full bloom. It seems probable that these stem-mothers must have hatched fully two weeks prior to this date to have become fully grown. The green apple aphid (*A. pomi*) at this time was just hatching and none were found that were more than half grown.

The identity of the louse was not suspected until the department artist, Miss M. A. Palmer, suggested that the second brood lice looked like her drawings of the clover louse, *A. bakeri*. A careful comparison indicated that the two forms were identical except for a little difference in color. This second generation (the offspring of the stem mothers) were light green or yellowish green in color, while *bakeri*, upon clover, is pink or yellowish. A large pale orange blotch surrounding each cornicle is also quite characteristic. Sprigs of apple infested with this louse were put in a cage with red clover and the lice in all stages readily adopted the clover as their food plant. Later the pink form was also found upon apple and crabapple (*Crataegus sp.*) and no doubt was left that all were one species with variations in color.

#### FOOD PLANTS AND LIFE HISTORY

Summing up the life habits of this insect from all the observations we have upon it in the records of the Experiment Station for the past nine years we conclude as follows:

The clover aphid, *A. bakeri*, infests the cultivated and sweet clovers and alfalfa throughout the warmer part of the year where, apparently, it never occurs in the oviparous form nor as eggs. In the fall, a portion of the winged lice migrate to apple and pear trees where eggs\* are deposited to live over winter and hatch into the red stem mothers the following spring. The descendants of

\* Oviparous females and eggs we have not seen with certainty.

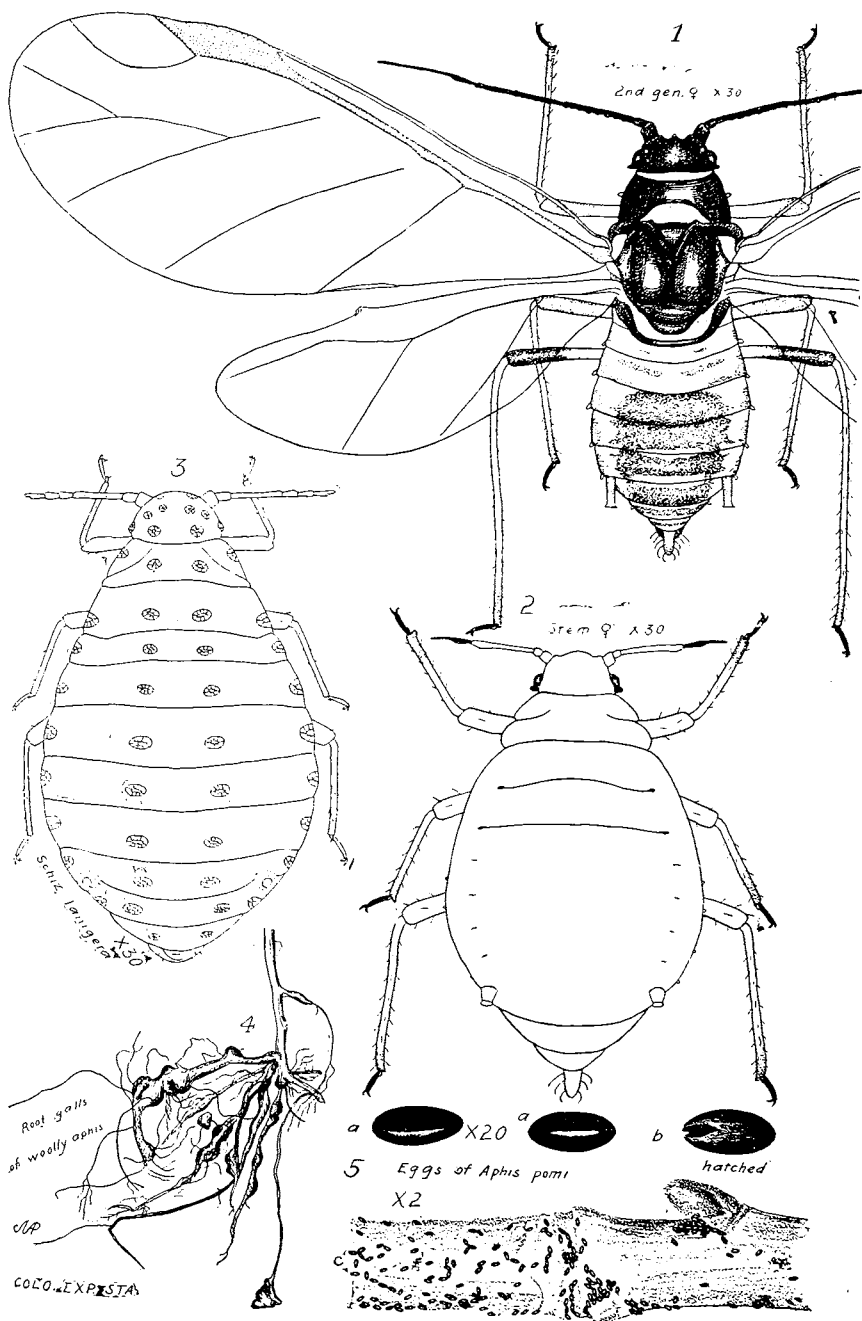


PLATE III. Fig. 1. Winged viviparous female of *Aphis bakeri*; 2. Stem mother of *Aphis bakeri*; 3. Wingless viviparous female of *Schizoneura lanigera* showing wax glands; 4. Root galls of woolly aphid of the apple; 5. Eggs of the green apple aphid (*Aphis pomi*), a. Eggs much enlarged; b. Egg shell after the louse had hatched; c. Apple twig with eggs upon it. Figures 1, 2, and 3 are enlarged 30 diameters; figure 5, a. and b. enlarged 20 diameters, c. enlarged 2 diameters.

M. A. PALMER, Artist.

these stem females begin in the second generation to get wings and by the middle of June nearly all have left the trees and gone back to the clovers,\*\* though some remain on the apple all summer. In the fall, many of the lice continue upon the clovers, going down close to the ground as cold weather comes on, and if the winter is not very severe, many will survive and continue to live and increase upon these plants throughout the year. Mr. L. C. Bragg has carried this louse through the winter in the laboratory upon red clover without trouble, but no eggs or egg-laying females were obtained.

So far as our observations have gone, this louse ranks next to the green apple aphid (*Aphis pomi*) in numbers as a leaf infesting species of the apple. Mr. George P. Weldon reports it as having a tendency to accumulate in the apple blossoms, but we can hardly consider it a serious pest as yet in Colorado orchards.

*Remedies* the same as for the green apple aphid except that the application to kill the stem-mothers should be applied earlier, fully a week before the leaf buds begin to open at all.

#### THE EUROPEAN GRAIN APHIS

(*Aphis (Siphocoryne) avenae* Fab.)

This louse was found in a few apple orchards in the Grand Valley in 1907, and during the spring and early summer of 1908 it was observed in small numbers upon fruit spurs and succulent sprouts upon the trunks and large limbs of apple, pear and quince, in the orchards about Delta, Paonia, Montrose and Rockyford. Mr. Weldon reported it on apple at Montrose as late as June 18. In no case has it been found in sufficient numbers to do appreciable harm. In our experience the apple has been the preferred tree, and colonies upon the pear and quince have been rare.

This louse is readily separated from any of the other species here mentioned by the alternating transverse stripes of light and of dark green that cross the body above, by the light colored cornicles with black tips that are present in both young and adult forms, and by the very short second fork in the third transverse vein of the fore wing of the winged forms. It curls the leaves in a manner similar to the green apple aphid, *Aphis pomi*.

This insect was first described in Europe by Fab., as a grain louse, and it was not until 1894 that Mr. Theodore Pergande\* discovered that it also feeds upon the leaves of apple trees during a portion of the year. It is said to be the most abundant apple leaf aphid of the eastern states.

\*\* July 8, and again Aug. 16, '08, several colonies were found on apple about Fort Collins. Mr. Weldon reported this louse on apple at Delta, Colo., July 12, '08.

\* Bull. 44, Div. of Entomology, U. S. Dept. of Agr.

## LIFE HISTORY

The lice that first appear in the spring, the stem-mothers, hatch quite early, before the buds begin to open at all, from little shining black eggs that were deposited upon the bark of the twigs the preceding fall as in case of the common apple aphid. These stem-mothers are fully as forward as those of the clover aphid. They were mature and depositing young of the second generation in the orchards about Delta as early as April 14th this year.

The stem-mothers are rather deep green in general color with the head and tail ends of the body lightest in color, and the green may or may not take the form of lighter and darker transverse stripes. They do not acquire wings.

These first lice give birth to young for two or three weeks, or somewhat longer, and then die. Some of these second generation lice get wings and leave the trees. What lice are left produce a third generation which more largely become winged and leave, according to Pergande, to go upon certain grasses, especially oats, wheat, barley, and rye, where they continue to increase in numbers until late in the summer or early in the fall, and the winged migrants leave the grains and grasses again and return to the trees. Here they probably give birth to the true males and females, the latter of which deposit the eggs to remain over winter and hatch the stem-mothers to start the complex round of development for another year. (We have not yet traced the fall stages, nor have we been able to colonize it upon the grasses from the apple.)

We have not prepared technical drawings for this louse\*

## THE ROSY APPLE APHIS\*

(*Aphis pyri* Boyer.)

A rosy tinted aphid of doubtful determination appeared in con-

\* For illustrations of this louse see Pergande's figures, Bull. 44, Bureau of Ent.; also Sanderson's 13th Rep. Del. Exp. Sta., p. 139.

\* This seems undoubtedly to be the louse that Sanderson described and figured in the 13th Annual Report of the Delaware Experiment Station (1901), as *Aphis sorbi*. Quaintance, Circular 81, Bureau of Entomology (1907), considers this to be *Aphis malifolia* Fitch, but Fitch describes this louse as being "of a shining black color throughout," and also states that "the legs are entirely black." None of the lice we have taken fill these requirements. Specimens of *Aphis sorbi* from Europe sent by Dr. Cholodkovsky and taken by him from *Sorbus aucuparia*, the original food plant of this species, fit well into Kaltenbach's description, and are doubtless that species. While the Colorado material possesses the four dorsal spines in front of the cauda and has the general color markings of *sorbi*, the dorsal tubercles are smaller and the lateral tubercles of the abdomen and thorax are much weaker. The larvae and pupae sent by Dr. Cholodkovsky have the cornicles unusually large and strongly tapering, while in our material the cornicles are not excessive in size. On the whole, our Colorado louse seems more nearly to correspond to the descriptions and figures of *Aphis pyri* Boyer, as given by Koch, and also by Buckton, and these descriptions and figures seem also to correspond very well with the characteri-

siderable numbers upon individual trees in some of the orchards of the Grand Valley last year. It attacks the leaves, causing them to curl exactly as in the case of the green apple aphid, but it is readily distinguished from that species by the pink color, especially of the wingless forms, and by the slight covering of a white powdery material. The winged lice have their head and thorax nearly black, but the abdomen is yellowish or rusty brown about the margins and dark brown over the middle portion, and never green or black as in the other species mentioned upon the apple. We are calling this, rather doubtfully, *Aphis pyri* Boyer. Remedies the same as for the green apple aphid (*Aphis pomi*).

#### THE SWEET CLOVER APHIS

(*Aphis medicaginis* Koch.)

This small black plant louse, while having a decided preference for certain legumes, as the sweet clovers, the locos, black locust, and wild Licuorice (*Glycyrrhiza lepidota*), feeds to some extent upon a very wide range of plants. We have frequently found it upon tender new shoots of apple and other fruit trees early in the season, and have received inquiries concerning it.

The wingless lice, when fully grown, are very deep shining black. Other wingless individuals of the colony are dark green to slaty gray but not black. From these colors alone the orchardist will be able to distinguish this from other species attacking the apple. Whether the colonies of this louse upon the apple came from stem-mothers hatching from over winter eggs has not been determined. We have never seen the eggs or true sexual forms of this species anywhere. It is not likely that this louse will ever become a serious orchard pest.

#### PEACH PLANT LICE

##### THE GREEN PEACH APHIS

(*Myzus persicae* Sulz.)

Plate II, Figs. 5 to 11.

This is by far the most abundant peach louse in Colorado. It seems to have been brought to this country from Europe where it was first described by Sulzer as a peach insect in 1761. Forty years later Shrank, finding it upon *Dianthus* (the pink) gave it the specific name *dianthi*. Koch in Germany redescribed it under

zation of *malifolii*, as given by Fitch. So we are calling our rosy apple aphid *Aphis pyri* Boyer, until we get further light upon the subject.

It might be added that the *Aphis sorbi* described by Buckton, Vol. II, p. 83, and which is referred to by Schouteden as this species in his paper ("Catalogue des Aphides de Belgique," p. 228), in "Memoires de la Soc. Entom. de Belgique, T. XII," is not *sorbi* unless both the descriptions and the illustrations are very incorrect, and the specimens we have from Dr. Cholodkovsky incorrectly determined.



the same name in 1854, and especially tells of taking it from Calla lily and the Oleander. Walker, an English writer about 1849, speaking of this louse says that it feeds upon at least sixty known plants and names the potato, turnip, cabbage, lily, carnation, tulip, tobacco, peach, nectarine, and many others. Buckton, in his "Monograph of British Aphididae" in 1879, speaks of this

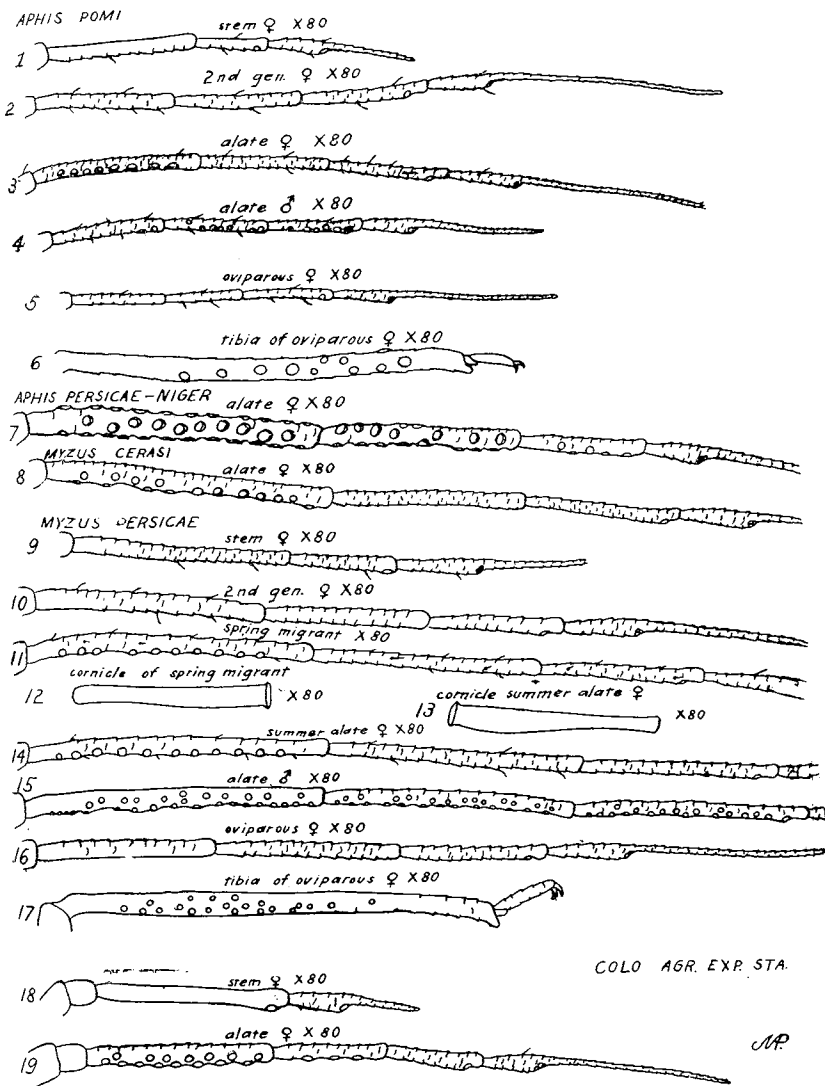


PLATE IV. Antennae, tibiae and cornicles of plant lice.  
 M. A. PALMER, ARTIST.

louse as being almost "polyphagous," on account of its feeding upon so many different plants.

In America this louse has also been reported under different names upon the peach, plum, cherry and man succulent plants, including several of our garden vegetables. The *Rhopalosiphum solani* of Thomas, occurring in abundance upon potatoes in Illinois; the *Siphonophora achryantes* of Monell, and the *Mysus malvae* of Oestlund\* are almost certainly this *persicae* of Sulzer, which was described nearly a century and a half ago. Since arriving at the above conclusions\* a letter has been received from Dr. N. Cholodkovsky of St. Petersburg, to whom specimens of this louse were sent and which were determined by him as being the *persicae* of Sulzer which he considers identical with the *dianthi* of Koch.

#### NAME AND LIFE HISTORY

There are two main reasons why this insect has been described under so many different names. It has a habit, which is not uncommon among the plant lice, of spending the fall, winter and spring of the year upon certain trees and shrubs, and the remainder of the year upon succulent vegetables. The winged form occurring upon the trees in the spring of the year (Plate II, Fig. 8) has its cornicles cylindrical in form while the winged individuals occurring upon succulent vegetation during the summer and fall, and those that return to the peach and other trees in September and October, (Plate II, Fig. 9) have their cornicles moderately swollen. The latter type of cornicle puts this louse into the genus *Rhopalosiphum*, while the former type of cornicle with the swollen antennal tubercles and first antennal joint, puts it into the genus *Mysus*. The other reason for the numerous names is its feeding upon a very wide range of plants.

So we are unable to avoid the rather sweeping conclusion that the green peach louse with its cylindrical cornicles, its pink egg-laying females in the fall and similarly colored stem-females in the early spring, is only the tree form of the green louse with club shaped cornicles that is so abundant in green-houses upon carnations, snapdragons, lilies, and many other flowering plants and out of doors cabbage, cauliflower, radish, turnip, potato, and a host of other vegetables, both wild and cultivated, which has been des-

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\* The *Rhopalosiphum sonchi* of Oestlund, which, in "Synopsis of the Aphididae of Minnesota," he seemed inclined to give up to *Rhopalosiphum dianthi* of Shrank, is probably a good species. At least, the native *Sonchus* growing in the vicinity of Fort Collins is badly infested with a *Rhopalosiphum* that is certainly distinct from the louse here discussed, and it fits in every particular the description given by Professor Oestlund for *R. sonchi*.

\* See Journal of Economic Ent., Vol. I, No. 2, p. 84.

ignated by the various names given above along with others that we have not mentioned.

This insect, then spends the winter, either as wingless lice upon succulent vegetables where there is sufficient protection to enable them to endure the cold weather, or in the egg stage upon certain trees, chiefly the peach, plum, apricot, nectarine and cherry.

The eggs are shining black in color and are deposited in the axils of the buds for the most part, but some occur in crevices of the bark. The eggs hatch very early in the spring so that the young stem-mothers (Fig. 5) from them are often almost fully grown before the earliest peach or plum blossoms open. About the time the buds begin to open upon these trees, the stem-mothers are all of a deep pink color and begin giving birth to living young. These young (Fig. 6) instead of being pink like their mothers are pale yellowish green throughout their lives, and usually there is a median and two lateral dark green stripes passing over the abdomen. Very few of this brood attain wings. The third generation become very largely winged (Fig. 8) and begin leaving the trees upon which they were born about the middle of May in the peach growing sections of the state. By the middle of June these lice have almost completely left the trees and may be found establishing their colonies upon various succulent vegetables, a list of which is given below. At this date, (Aug. 1, '08) this louse in the insectary, bred directly from specimens taken from the peach in Fort Collins, June 20, are all apterous and the body color is a uniform pale yellow without green markings.

#### FOOD PLANTS

The plants upon which we have found this louse establishing colonies in Colorado are as follows:

##### IN GREENHOUSE

Snapdragon ( <i>Antirrhinum</i> sp.)	White clover ( <i>Trifolium repens</i> ).
Carnation ( <i>Dianthus</i> sp.)	Verbena sp.
Potato ( <i>Solanum tuberosum</i> )	Russian thistle ( <i>Salsola tragus</i> ).
Radish ( <i>Raphanus sativus</i> )	Cotton ( <i>Gossypium herbaceum</i> ).
Alternanthera.	Box-elder ( <i>Rulac negundo</i> ).
Calla lily ( <i>Richardia Africana</i> ).	Snowball ( <i>Viburnum opulus</i> ).
<i>Lilium candidum</i> .	Apple ( <i>Pyrus malus</i> ).
Tulip ( <i>Tulipa</i> sp.)	Wheat ( <i>Triticum sativum</i> ).
Cauliflower ( <i>Brassica oleracea</i> ).	Grass ( <i>Poa</i> sp.)
<i>Lactuca spicata</i> .	Corn ( <i>Zea</i> sp.)
Turnip ( <i>Brassica rapa</i> ).	Willow ( <i>Salix</i> sp.)
Tobacco ( <i>Nicotiana Tabacum</i> ).	Castor bean ( <i>Ricinus communis</i> ).
Egg-plant ( <i>Solanum Melongena</i> ).	<i>Cineraria</i> sp.
<i>Amaranthus</i> sp.	Pot Marigold ( <i>Calendula officinalis</i> ).
<i>Chenopodium album</i> .	Petid Marigold ( <i>Drysdia</i> sp.).
Water Cress ( <i>Roxipa Nasturtium</i> ).	<i>Digitalis purpurea</i> .
Asparagus fern ( <i>Asparagus</i> sp.)	<i>Primula Forbesi</i> .
Nasturtium ( <i>Tropaeolum majus</i> ).	<i>Stellaria media</i> .
Red Clover ( <i>Trifolium pratense</i> ).	<i>Iresine lindenii</i> ( <i>Achyranthes</i> ).
	Tomato ( <i>Lycopersicum esculentum</i> ).

**Malva** sp., native.

**Tansetum balsamifera**.

Poppy, cultivated.

**Vinca** sp.

**Vicia** sp.

Lupine, native wild pea.

Sugar beet (**Beta vulgaris**).

Cantaloupe (**Melo** sp.)

Watermelon (**Citrullus vulgaris**).

Native thistle (**Carduus** sp.)

**Chrysanthemum** sp.

**Marsilea vestita**.

Golden glow (**Rudbeckia** sp.)

Cactus (**Opuntia** sp.)

#### OUT-OF-DOORS

Trees upon which eggs are laid.

Peach (**Prunus persica**).

Plum (**Prunus domestica** and **Americana**).

Choke cherry (**Prunus Virginiana**).

Prune (**Prunus domestica**).

Nectarine.

Tame cherry (**Prunus cerasus**).

Apricot (**Prunus Armeniaca**).

Sand cherry (**Prunus melanocarpa**).

#### SUMMER FOOD PLANTS ONLY

Cabbage (**Brassica oleracea**).

Cauliflower (**Brassica oleracea**).

Rape (**Brassica napus**).

Turnip (**Brassica Rapa**).

Potato (**Solanum tuberosum**).

Tulips (**Tulipa** sp.)

Pansy (**Viola tricolor**).

Pigweed (**Chenopodium album**).

Radish (**Raphanus sativus**).

**Amarantus** sp.

**Chenopodium** (**Bonus-Henricus**).

**Malvastrum coccineum**.

Wild mustard.

**Lepidium** sp.

Dock (**Rumex** sp.)

**Bursa Bursa-pastoris**.

Tomato (**Lycopersicum esculentum**).

Water cress (**Nasturtium officinale**).

Apple (**Pyrus malus**).

Pear (**Pyrus communis**).

Lilac (**Syringa vulgaris**).

Castor bean (**Ricinus communis**).

Morning glory (**Convolvulus** sp.) wild.

Hollyhock (**Althaea rosea**).

Horseradish (**Nasturtium armoracea**).

*Immune plants*—The following plants in the insectary were not infested: onion, beognia, oxalis, (four-leaved sorrel), and coleas.

Apparently, the only reason why the above list of infested greenhouse plants is not larger is because there was not a larger list of plants growing in the greenhouse at the time. It seems that this louse will feed upon almost any tender green foliage early in the spring, or late in the fall when most plants have died out and the lice are hard pressed for food.

A plant louse like this that is able to spend the winter either upon trees in the egg stage or as a louse upon succulent vegetables that are somewhat protected from the extremes of low temperature, and with such a wide range of food plants, has a remarkable power to continue its existence in a locality where it has once been introduced.

#### INJURIES

When the peach trees bloom, this louse often attacks the blossoms in numbers sufficient to blight them. After the fruit forms they sometimes attack the young peaches in sufficient numbers to cause them to wilt and drop. They also attack the leaves causing them to curl and turn yellow in color and, if the attack is very severe, many of the leaves drop.

#### NATURAL ENEMIES

This louse is attacked by a large number of insect enemies and it is probable that its severe struggle for existence with these

foes is what accounts for its wide range of food plants and its intricate life history.

The predaceous enemies such as lady-beetles, syrphus flies and lace-wing flies are very abundant about the colonies of this insect, and at least two small internal parasites\* also destroy them.

#### REMEDIES

About a week before the buds open, spray the trees with the ordinary strength of kerosene emulsion (one-fifteenth oil) or with Black Leaf 1 to 65 in water, or with some other good plant louse spray recommended for the green apple aphid. After the trees have blossomed, if the lice become abundant at any time, spray as for the green apple aphid.

If the peach trees are to be treated with lime-sulfur for twig borer, or brown mites before the buds open, that application should kill nearly all of the stem mothers of this louse too, if made a week or ten days before the buds open.

#### THE BLACK PEACH APHIS

(*Aphis persicac-niger* Smith)

Plate I, Figs. 12, 13, 14.

This louse has long been known as a pest in peach orchards in the United States where it seems to be a native insect. This seems strange, however, as the peach is a native of Asia and appears to be the only food plant for this louse. We first noted the black peach aphid in Colorado in 1905. It has not become very generally distributed in the peach orchards of the State as yet, but is known to occur in a few localities upon the western slope and at Canon City. The infested orchards are so situated, however, that it will be an easy matter in a few years for the louse to distribute itself throughout nearly all the important peach sections.

It is important, therefore, for all who grow peaches to give the closest attention to their orchards for the purpose of detecting this louse as soon as it appears and destroying it, before it becomes so widely distributed that it cannot be kept under control.

#### APPEARANCE OF THE INSECT

This louse differs quite widely in its habits and appearance from other species that attack the peach, and is one that any fruit grower can readily determine if he will give close attention to the characterization here given.

\* A species of *Lysiphlebus* destroys large numbers, especially in green-houses, and we have also a number of the lice killed by a very minute Chalcid (*Aphelinus* sp.), which causes the lice to turn deep shining black in color. Lice parasitized by *Lysiphlebus* become swollen and turn to a gray, or light drab color. Those killed by the Chalcid retain their natural shape. Determined for us by Dr. L. O. Howard.

While this insect is known as the Black Peach Aphis, the greater number of the individuals in any colony are always of a reddish-yellow or amber color (Plate I, Fig. 13). It is only the full grown lice that are black, whether winged or wingless, and none of the individuals are ever green in color. The fully grown wingless lice are deep shining black and highly polished (Plate I, Fig. 12).

The other lice occurring upon the peach attack the foliage and blossoms and in some cases the young peaches, but none of them attack the year-old bark of the limbs as does this one.

#### LIFE HISTORY

This louse appears very early in the season. Last year it was found in Delta County and also in the vicinity of Palisades, early in February in considerable numbers, and badly infested twigs were received from Paonia that were taken March 18, 1908. These early appearing lice confine their attacks to the tender bark of the twigs and are nearly always most abundant at first upon small limbs or sprouts near the ground. The tender twigs may be literally covered with the lice before the leaves open at all. When the buds do open, exposing the leaves and blossoms, some of the lice migrate upon these tender parts. They may kill the little peaches, and if at all abundant upon the leaves, the latter curl and protect the lice from storms or from the insecticides that may be thrown upon the tree by the orchardist.

The lice that appear upon the trees early in the season are all wingless. The winged examples begin to appear in the vicinity of Grand Junction about the last of April. By the tenth of May these winged lice are usually very abundant, and by the middle of May, in our experience, the lice have begun to disappear from the peach trees, and very few have been found in the orchards after the 15th of June.

It is said that this louse migrates to the roots of the peach trees where it spends the fall and winter coming back to the top early in the spring. This part of the life history we have been unable to verify although we have dug about many peach trees in search of the lice.

That it is the habit of this insect to pass the winter upon the roots of trees seems highly probable as we have been unable to find any sexual forms or eggs, and we are not aware that any one has.

In the older peach growing sections of the country this aphid has been reported as frequently killing peach trees, especially small ones in nurseries.

#### PREVENTION AND REMEDIES

It is not very uncommon for horticultural inspectors to find

this louse present upon the roots of nursery stock that has been shipped into the state. Undoubtedly the lice present in Colorado today, have descended from those brought to the state in this manner, and not in the egg stage.

It is a matter of much importance then, to treat all nursery stock coming to Colorado in such a way as to prevent any possibility of introducing this louse into the peach orchards upon nursery trees.

This may be done either by a thorough fumigation of the stock with hydrocyanic acid gas; or by thoroughly and forcefully spraying it with kerosene emulsion, a good quality of whale oil soap, or a tobacco decoction, before planting.

If the louse has been introduced into the orchards and is found to be present upon peach trees it is highly important that the owner keep a very close watch over his trees especially in the early spring time for the purpose of detecting the first appearance of these lice, which would probably be during the latter part of February or sometime in March in the warmer sections of the state. In the colder sections where peaches are grown to some extent, the earliest date of their appearance would probably be the latter part of March or very early in April. As indicated above, the louse may become very abundant before the buds open at all, and that is when treatment of orchards trees can be made most effective and with least expense. So far as our observations have gone, the lime-sulfur preparations have not been satisfactory for the control of this louse, but it is very readily killed by the ordinary application of soaps, tobacco preparations or oil emulsions. We would especially recommend kerosene emulsion that is 1-15 oil; "Black Leaf," 1 gallon in 65 gallons water; or home made tobacco decoction. If the treatment is made one week before the buds begin to open, the green peach aphid will also be killed by the same application.

Thorough treatment should always be made before the winged forms begin to appear, which may be as early as the middle of April.

This louse is very gregarious in habit so that it will often be the case that one or two trees, or even one side, or a few limbs upon a tree, may be quite badly attacked when no other infested trees are found in the orchard.

### PLUM LICE

Besides being attacked somewhat by the green peach louse (*M. persicae*) plum and prune trees have three other species of plant lice of considerable importance in Colorado.

#### THE MEALY PLUM LOUSE

*Hyalopterus arundinis* (Fab.)

This is a light green louse that colonizes the underside of the

leaves of plum and prune trees. It often is so numerous that the under leaf surface is completely covered by the lice.

The stem-mothers hatch from black shining eggs deposited upon the twigs of the trees late in the fall. They locate upon the underside of young growing leaves where they give birth to a large number of living young which, so far as we have observed, do not acquire wings. At Austin, Colorado, May 22, '08, many of the second generation were mature and producing young. In the earlier sections this louse becomes very abundant by the 10th to the 15th of May and may continue to about the 15th or 20th of July when nearly all will have acquired wings and left the trees. About Fort Collins, at least, we find that occasional colonies of this louse remain upon plum trees throughout the summer.

Upon leaving the plum, the lice go to certain grasses to feed during the summer. We have specially found it infesting Reed-grass, *Phragmites Phragmites*, on wet ground and along ditches upon the western slope in Colorado.

About the middle of September\* the fall migrants begin to return to the plum trees and to give birth to the sexual males and females. The males are winged and the females wingless. The latter deposit the eggs that remain over winter.

This louse may be easily distinguished from other plum infesting species by its light green color, with three longitudinal darker stripes above, the white powdery covering to the body, the long narrow body, the short cornicles, and the small second fork in the third sector of the fore wing. The leaves when loaded with this louse, may drop and become yellow but they do not curl as is so often the case in plant louse attacks.

#### REMEDIES

The lice will leave of their own accord by about July 10 in the warmer portions of the state and a little later in other sections. If found very abundant before July 1st, it will doubtless pay to make a thorough spraying with kerosene emulsion or Black Leaf as recommended for the green apple aphid.

This louse seems to have few natural enemies to keep it in check.

#### THE HOP PLANT LOUSE

(*Phorodon humuli* Schrank)

This is another green louse that inhabits the plum as a winter host plant. This louse is specially noted for its severe injuries to the hop during the summer months. It is generally distributed in the state and has frequently been taken by us upon both cultivated

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\* September 16, 1906, is our earliest date for return migrants to the plum.



and wild hops and upon plums.

At Fort Collins we have followed it upon the plum in moderate numbers throughout the entire season, and Mr. W. T. Clark\* has reported it remaining upon the hop vines in California until the males and egg-laying females have been produced. So it seems probable that this louse can exist from year to year upon either of these food plants in the absence of the other.

For an excellent account of the life habits of this insect and colored figures of the different stages, see an article by C. V. Riley in Department of Agriculture Report for 1888, p. 93.

While we have not observed the stem-mothers in Colorado, we find the louse appearing during May and the early part of June upon the leaves of plum trees. Most of the lice acquire wings and leave early in July in the vicinity of Fort Collins, though on July 8, 1907, trees were seen badly infested with this louse and there were many wingless adult females still present.

#### APPEARANCE OF THE LICE

The wingless lice are light green or greenish yellow without noticeable markings of other colors. The winged lice have the same general body color with head, plates of the meso-thorax above, and a few dashes upon the abdomen black. All the lice are specially marked by having upon the head, at the base of each antenna, a prominent tubercle or tooth, and a less prominent one projects from the inner side of the first joint of the antenna.

About the middle of September at Fort Collins the winged return migrants begin to come from the hops and alight upon the leaves of the plum. A note made at that place October 3, '07, reads: "The winged migrants are fairly common on plum leaves now and most of them have a small colony of young surrounding them." These young develop into the wingless egg-laying females (and possibly winged males also) and a little later the eggs are deposited upon the twigs to live over winter.

#### REMEDIES

The same as for the green apple aphid.

#### THE RUSTY BROWN PLUM LOUSE

(*Aphis sctariae*. Thos.)

This plum louse is readily distinguished from any of the other species mentioned in this bulletin by its dark rusty brown color together with the conspicuous white base of the antennae, entire tibiae, and tail or cauda.

This louse appears early in the season upon the bark and leaves of the tender new shoots of plum trees. We have found it

\* Bull. 106, Calif. Experiment Station, 1904.

specially upon the red or Americana plums. Throughout the season it seems to have a strong tendency to cluster upon the bark of the tenderest new growth.

The louse is nearly always accompanied by ants, that attend it for the honey dew that is secreted. Usually in the colonies a few larvae of one of the small black Coccinellids (*Scymnus* sp.) can be seen. They are recognized at once by the white secretion that covers their bodies.

This louse remains upon the plum throughout the entire year. We have found it in many places east of the mountains both in the vicinity of Fort Collins and in the Arkansas Valley, but we have not taken it on the western slope. It often becomes abundant enough to be a very serious pest, but on account of its body being entirely free from any powdery secretions, it is readily treated and destroyed. From about the first of August on through the summer we have also found this louse upon barnyard grass (*Echinochloa Crus-galli*.) The louse becomes darker in color late in the season and the oviparious female in the fall is almost black. The small winged males are black in color. The egg-laying females are wingless and, in the laboratory, Mr. Bragg succeeded in getting them to lay eggs quite freely upon plum twigs, but he was unable to find any of the eggs upon infested plum trees out of doors. The lice upon plum trees during September and October were all apterous except the males, but whenever found upon barnyard grass there were many winged individuals present that seemed to be fall migrants.

Mr. J. T. Monell\* reported this louse upon *Panicum proliferum*) in Missouri, and Professor O. W. Oestlund\*\* reports it upon fox-tail (*Setaria glauca*), barnyard grass (*Echinochloa Crus-galli*) and Virginia Creeper (*Ampelopsis quinquefolia* in Minnesota.

#### REMEDIES

The remedies for this louse are the same as for the green apple aphid, without the early treatments for the destruction of eggs.

### THE BLACK CHERRY LOUSE

(*Myzus cerasi* Fab.)

Plate II, Figs. 1, 2, 3, 4.

This is an insect that has long been known in Europe and for more than half a century, at least, has been a pest upon cultivated cherries in the eastern portion of this country. It is generally distributed through the orchards of the eastern slope of the Rocky Mountains in Colorado and has found its way into a few orchards,

\* Bull. 5, U. S. Geol. Survey, p. 23, 1878.

\*\* Aphids of Minn., p. 67, 1887.

in the valley of the Gunnison. Prompt action on the part of the orchardists where it occurs would almost exterminate it from our Western Slope.

Both the winged and wingless forms of this louse are deep shining black, the body is rather broad and flat and the cornicles are long and cylindrical. Cherry foliage may be fairly blackened by the lice before the early cherries mature.

Dr. C. M. Weed,\* who studied this louse in Ohio, found winged lice appearing in great numbers about June 10 to July 1st, and all lice disappeared by the latter part of July and remained off the cherry until late in September when he began to find winged migrants again. Though no alternate food plants were found, Dr. Weed was convinced that such plants existed and that it is the instinct of the louse to entirely leave the cherry trees during the late part of the summer. We have followed this louse quite closely for two years past about Fort Collins and have found its habits about as follows:

The lice first attract attention about the last of May upon sprouts about the trees, then upon the lower limbs, and by the middle of June may be all through the trees. About the first week in July their enemies, especially the lady-beetles, become very abundant and the lice rapidly disappear so that by the middle or latter part of the month they can only be found in scattered isolated colonies. Some of these escape their enemies and the lice gradually increase in numbers again late in August and in September, but, so far as we have observed, do not again become very numerous. At least, this louse did continue in this manner throughout the entire summer in 1907 and 1908 about Fort Collins where it was closely watched for us by both Mr. L. C. Bragg and Mr. T. D. Urbahns.

Up to about June 15th. at Fort Collins, practically no winged lice can be found and by July 1st. the great majority of the lice are either winged or pupae, and a good proportion of winged individuals continue in the colonies throughout the season.

Besides the observations of the writers, Mr. L. C. Bragg has spent a considerable portion of his time every week of the year for more than two years past inspecting plants of every kind growing in the vicinity of Fort Collins, yet this louse has never been seen by any of us upon any plant but the cultivated cherry. We are obliged to conclude, therefore, that this louse has no other regular food plant in Colorado.

#### REMEDIES

This louse should be treated with kerosene emulsion or one of the tobacco preparations before the winged lice appear to spread

\* Bull. Ohio Experiment Station, Technical Series, Vol. I, No. 2, p. 111, 1890.

the species from tree to tree. The earlier this is done after the lice first appear the better, for then they are nearly all accumulated upon a few sprouts or limbs near the ground.

PREPARATION OF THE INSECTICIDES MENTIONED  
IN THIS BULLETIN.  
KEROSENE EMULSIONS

The standard formula for mixing the stock solution of kerosene emulsion is as follows:

Water 1 gallon.

Tak-a-Nap, Whale-oil, or Laundry soap 1-2 pound.

Kerosene, 2 gallons.

For use, dilute with water to secure the desired percentage of oil.

For example, if a spray containing 5 per cent oil is desired, use 3 3-4 gallons of the stock solution, and dilute with water to make 50 gallons of spray. If a 6 per cent spray is desired, use 4 1-2 gallons of the stock solution to make 50 gallons of spray, or if a 7 per cent spray is desired, use 5 1-4 gallons of the stock solution in making up 50 gallons, or practically 1 part stock solution to 9 parts of water. This last named strength is the one most commonly used for the destruction of plant lice upon plants while they are in foliage. Larger amounts of the stock solution may be prepared using the same ratio. If a stronger spray is to be used than those given above, it is only necessary to dilute with a smaller proportion of water, bearing in mind in computing the percentage of oil in the spray that the stock solution is two-thirds oil.

The necessary steps are: Dissolve 1-2 pound soap in 1 gallon boiling water. While boiling hot add this to 2 gallons kerosene and briskly agitate for about five minutes. A creamy mixture will be formed which, when diluted with water, will mix readily without allowing free kerosene to rise to the top. After agitating, add a small quantity of the stock solution to a bucket of clear water for trial. It should mix completely through the water, like milk. If it rises to the top as free oil, the stock solution will have to be heated again to boiling and churned until it will stand this test. To avoid accidents, the boiling solutions should be removed from the fire when it is mixed with the kerosene. An emulsion can be formed with greater ease if the oil is also warmed, but the heating of kerosene over a live fire, for safety, should only be attempted out of doors and away from all buildings. The mixture must be watched closely also to prevent its boiling over the sides of the vessel and igniting.

Mixing the emulsion is not a difficult operation. It can be done by any orchardist. The essentials of success are in having the soap suds *boiling hot* when the solutin is added to the kerosene, in

giving *immediate and thorough agitation* when the boiling soap-suds and kerosene are poured together, and in the use of clean soft water.

The apparatus may vary with the amount to be prepared. Those preparing to use several spray tanks of the material and possessing a gasoline power spray outfit find it most convenient to perform the agitation by placing the boiling hot soap-suds and the kerosene together in the spray tank and forcing the mixture through the pump. This churns the liquid thoroughly. Mr. B. A. Smith of Grand Junction, successfully prepares enough of the stock emulsion at one time in this way for five two-hundred gallon tanks of 6 per cent spray. He first dissolves in a home-made cooking vat with galvanized iron bottom and wooden sides, thirty pounds soap with thirty gallons of water, and when this is boiling hot it is poured into the spray tank upon 60 gallons of kerosene previously emptied into the tank. The gasoline engine then forces the mixture through the pump and a short spray hose back into the tank under a high pressure for several minutes until oil and soap-suds are completely combined. The whole solution, about 100 gallons, is then run off into an extra dismantled spray tank and 1-5 of the stock solution used for each 200 gallon tank, thus giving approximately 6 per cent oil in the spray. The apparatus is equipped with a mechanical agitator in the tank which operates while the emulsion is being made, but the action of these mechanical agitators will not alone form a good emulsion, and the mixture must also be pumped as described out from the tank through a spraying nozzle hose and back into the tank again.

Enough for a two hundred gallon spray tank may be made in a 50 gallon barrel fitted with a good hand barrel pump for agitation. Smaller amounts may be prepared with wash-boilers or tubs as heating vessels for the soap-suds, and to contain the oil and soap-suds when being emulsified and a good hand bucket pump will perform the agitation. If a very small quantity is to be used for a few house plants an egg beater will suffice for the agitation.

Many kinds of soap may be used to prepare the emulsion. Tak-a-Nap soap, whale-oil soap and Laundry soap have been most commonly used by the growers. The cost of the soaps should be considered. Tak-a-Nap soap is a soft soap and dissolves readily. It should be heated to boiling in water when dissolved the same as other soaps insure the best results, instead of attempting to combine soap-suds and kerosene cold.

Those who have trouble in making kerosene emulsion can procure a commercial article known as "Aphisicide" manufactured at Grand Junction, or else use some other good contact insecticide instead.

## PRECAUTIONS

When preparing and using kerosene emulsion remember:

To use soft clean water is possible.

To have the mixture as hot as possible for emulsifying.

To see that the oil, or mixture of oil and soapy water does not boil over into the fire.

To see that the oil does not separate to form a layer of kerosene on top. If this condition exists, the last of the barrel or tank will be almost sure to burn the foliage.

To remember that the strength of the emulsion depends upon the percentage of oil it contains.

To use kerosene emulsion alone, do not try to combine it with arsenical sprays.

To apply forcefully and thoroughly so as to wet the insects as it only kills by coming in actual contact with their bodies.

## TOBACCO DECOCTION

Tobacco stems or tobacco dust two pounds.

Water four gallons.

Put the tobacco in the water which may be either cold or hot. Place over the fire and when the water has reached the boiling point, remove some of the fire and allow the water to simmer, but not boil,\* for fully one hour, when the liquid is ready to be drained off and applied.

If the whole leaf tobacco is used, prepare as above using one pound of tobacco to each four gallons of water.

No lime or other alkaline substances should be added to the tobacco while cooking. Apply at once, or within a few days after making.

## BLACK LEAF

There is nothing to do in the preparation of Black Leaf except to thoroughly stir the contents of the can before pouring out any quantity for dilution. In most cases one gallon of the Black Leaf will be found sufficient for each seventy gallons of water. If in the treatment of any louse this does not seem sufficient it may be used in the proportion of one gallon to sixty or sixty-five gallons of water. In fact, we have usually succeeded in killing plant lice with this preparation used in the proportion of one gallon to each one hundred gallons of water. Thoroughness of application is of as much importance as the strength of the material used.

If this substance is not obtainable in your home town it may be procured from the Watkins Merchandise Co., Denver, or from The Kentucky Tobacco Product Co., Louisville, Kentucky.

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\*Dr. W. P. Headden, Station chemist, says that nicotine will be partially driven off by boiling. A distillate he prepared killed lice when diluted to 1-8 strength.

## MISCIBLE OILS

There are several miscible oils upon the market which may be added directly to water forming a milky emulsion at once. In the preparation of any of these, such as "Scalecide," "Target Brand Scale Destroyer" or "Killoscale" add the oil directly to the water with a little stirring. One gallon of the miscible oil in fifty gallons of water will make a two per cent. mixture, which in most cases, should be strong enough to kill plant lice if thoroughly applied.

**LIME-SULPHUR MIXTURE** (FOR WINTER SPRAY ON FLOWERS OF SULFUR, FIFTEEN POUNDS)  
 Good lump lime, fifteen pounds. Water, forty-five gallons.

This is the 1-1-3 lime-sulfur mixture. First slake the lump lime with sufficient warm water, and while still boiling hot, add the sulfur and stir it in. Place over the fire and continue the boiling, adding water when necessary, until the mixture changes to a deep reddish brown color which indicates that the lime has cut the sulfur. It will be necessary to boil steadily for about forty minutes to one hour to produce this result. The mixture should then be diluted to form forty-five gallons of the spray, and should be applied at once.

When the lime-sulfur mixture is placed in the barrel or tank it should be strained through gunny sacking to take out all lumps that would clog the spray nozzle. If allowed to stand for any great length of time after being prepared, the lime sulfur crystalizes out to a considerable extent. In such a case it is necessary to heat the mixture again before applying so as to dissolve all the crystals. If the crystals are re-dissolved the mixture will be as strong as before.

To make 1-1-2 lime-sulfur mixture, prepare as above using only thirty gallons of water for the fifteen pounds of lime and the fifteen pounds of sulfur.

For the 1-1-4 lime-sulfur mixture prepare in the same manner, but dilute to sixty gallons before applying.

## REX LIME-SULFUR

We have found the Rex lime-sulfur in the proportion one gallon of the Rex to seven or eight gallons of water to be just about equal in effect to the 1-1-3 home made lime sulfur preparation.

## WHALE-OIL, OR FISH-OIL SOAPS

The so-called Whale-oil or fish-oil soaps which are quite extensively used for the destruction of plant lice will usually be effective if thoroughly applied in the proportion of one pound of the soap to each six or eight gallons of water. There are numerous brands of these soaps upon the market. Those that we have used successfully are Good's Whale Oil Soap and Bowker's Tree Soap.

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## EXPLANATION TO PLATES

Plate I, page 16: The Green Apple Aphis, *Aphis pomi*—1, young stem mother; 2, adult stem mother; 3, adult apterous viviparous female, second generation; 4, young female, second generation; 5, winged viviparous female of third generation; 6, pupa of preceding; 7 and 8, apterous male and female. The Woolly Apple Aphis, *Schizoneura lanigera*—9, apterous viviparous female; 10, fall migrant; 11, over-winter young. Black Peach Aphis, *Aphis persicae-niger*—12, adult apterous viviparous female; 13, young female, first instar; 14, alate female; 15, *Chrysopa* sp. and eggs; 16, cocoon of preceding.

Plate II, page 32: Black Cherry Aphis, *Myzus cerasi*—1, apterous viviparous female; 2, alate viviparous female; 3, male. Green Peach Aphis, *Myzus persicae*—4, young stem mother, first instar; 5, adult stem mother; 6, young of stem mother; 7, apterous viviparous female of second generation; 8, spring migrant; 9, fall migrant; 10, egg-laying female; 11, eggs. Figs. 12, 13, 14, 15, the adult, the larva, the pupa, and the eggs of the common lady beetle, *Hippodamia convergens*.

MISS M. A. PALMER, Artist.

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## ERRATA

Plate IV, Fig. 4, read *apterous* for "alate."

Page 32, line 14 from bottom, read, *Figs. 4 to 11.*"