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—BY—

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WESTERN SLOPE FRUIT INVESTIGATION

Report of Field Entomologist*

SEASON OF 1906

E. P. TAYLOR, GRAND JUNCTION, COLORADO

The principal lines of work for the season have been—

(1) Experiments upon practical methods of controlling the principal insect pests of the orchard.
(2) Collection and study of other economic insects.
(3) Visitation of orchards by request or otherwise.
(4) Attendance at fruit growers' association meetings, farmers' institutes, county fairs, horticultural society meetings, etc., where questions relating to the work of this office were being considered.

The experiments carried on with injurious insects have been in cooperation with orchard men whose loss from these pests has invited tests of measures of control. The experiments have served as practical demonstrations in each neighborhood in which they were carried on, and have served as object lessons at the same time they were revealing new facts. They have been the objects of the deepest local interest. The territory covered by the demonstrative experiments has been thus far limited to points lying in the lower Grand Valley, principally in the orchard sections surrounding Grand Junction, Palisade, and Fruita.

CODLING MOTH. (*Cydia pomonella* Linn.)

Introductory—The codling moth has received the greatest share of attention. Spraying experiments have been completed in five orchards of the locality and the results successfully answer the principal questions relating to the control of the insect.

Probably no district in the United States is better equipped with modern spraying apparatus than the orchard district of Grand Valley. Nearly $100,000 are invested in spraying apparatus in the county of Mesa alone, but in spite of this fact, codling moth ravages have injured the fruit to the extent of a great many hundreds of thousands of dollars annually for some years past, and in spite of the fact that some orchardists have applied as many as ten or more sprayings per season. The past season has cost the growers, by careful estimate, over $36,000 for material used in making up their

*This bulletin is a companion to Bulletin 118, which gives the report of the Field Horticulturist for 1906, Western Slope Fruit Investigation.

The general plan for the entomological investigations were made by Prof. C. P. Gillette, and the work was under his direction.

The work was rendered possible by other funds than the government appropriations for the Experiment Station, a considerable portion from the fruit associations of Mesa County, and the remainder from the State Board of Agriculture.

arsenical sprays. This season's work has determined these failures to be due to several causes: (1) lack of thoroughness of method; (2) lack of proper spraying material, and (3) lack of knowledge of the exact life history of the moth.

The experiments demonstrated that this pest, the most important of all to the gruit grower of Colorado, may be conrolled by arsenical sprays applied properly and at the correct time.

The number of sprays required to control the moth in an orchard will depend principally upon (1) previous infestation of orchard; (2) proximity to other infested orchards; (3) efficiency of earlier sprays, and (4) variety of fruit.

To obtain results of greatest practical value to the fruit grower, orchard blocks of considerable size were chosen and given treatment in the most thoroughgoing and intelligent manner. Records of every detail were tabulated, and at the close of the season, in determining results, very large numbers of apples were given hand-to-hand inspection. For example, over 100,000 apples, representing upwards of 600 bushel boxes, were given a most critical examination to reveal, as nearly as possible, the exact outcome of the experiment.

Life History Studies—A study of the life history of the moth carried through the season showed many things of vital importance relating to the proper time to spray. No great variation or change of habit of the moth was noted. The time required for the passing of each stage of the insect was practically identical with other observations of the insect in the state. The time or dates of transformations of the moth were found, however, to be much earlier than for the majority of the other fruit sections of Colorado, and some variation exists between the different portions of the Grand Valley, transformations taking place earlier, as a rule, in the region about Palisade than in the country surrounding Grand Junction or Fruita.

Parasites—Natural parasites of the insect were studied, one of the most interesting being the minute bee, *Trichogramma pretiosa*, laying its eggs and developing within the tiny egg of the codling moth.

Bands—The use of bands is not discouraged, but they can not be depended upon alone to control the moth. If used, the old ones which have remained on the tree through the winter should be cleaned up by April 1st to prevent larvae from changing to pupae and moths making their escape. They should also be gone over at least every ten days through the summer until the middle or latter part of August, after which there will be little danger of moths emerging until the following spring.

Spraying Experiments—As stated, spraying with arsenicals was the standard remedy adopted, and the studies were made upon (1) Time to spray; (2) Kind of spray, and (3) Way to spray.

Time to Spray—The time to apply the first spray in the experiment conducted was determined by the condition of the calyx of the bloom, and that of the later sprays by careful and systematic observation for the appearance of the eggs of the moth.

Close observation of the calyx will determine when it is in an

ideal condition for spraying. This time should be following the dropping of the petals but before the closing of the calyx. A period not to exceed from five to seven days for any one variety would cover the time when this first spray should be applied. Sprayed too early or before the petals are fallen, bees about the bloom are in danger of being destroyed, and, sprayed too late, the green sepals will have come together at their tips, closing the calyx cup against all possibility of being filled with the poison.

The center blossoms are invariably the first to open their petals and first to drop them. They are first to close their calyces and most likely to set fruit which will remain without dropping from the tree. It is therefore evident that this first spraying should be done with these blossoms in mind. The first eggs do not appear for several weeks later. When the young larvæ hatch from these eggs, the larger per cent of them enter at the calyx, and if the first spraying has left the calyx containing a liberal amount of poison, their first meal will, in all probability, be their last. Sixty per cent or more of the first generation larvae, according to this summer's observations, entered at the calyx. For the remaining forty per cent or less entering at the side or stem end of the apple, a second spray must be applied early enough to coat the surface of the small apple with poison before the hatching larvae make their appearance, and this coating must be maintained upon the fruit until the first generation's eggs have hatched.

Other conditions being right, two sprayings with an adhesive arsenical will perform this end, and the first generation thus practically destroyed. There being but two full generations of the insect through the season, if the first be destroyed there should be no second left with which to contend.

As stated above, however, in common practice there will be cases where more than two sprays are necessary, and these additional ones should be directed against the second generation.

Any one may determine the proper time to spray by observations upon time of egg appearance, though in practice this is more or less difficult for the average orchardist.

The date of appearance of the blossoms upon fruit trees is dependent upon meteorological conditions for the spring. These same conditions regulate the initial appearance of the adult moth, and as its times for transformation are fairly constant thereafter, it seems possible that a general rule may be made for common use, based upon the blooming of the fruit in spring. Such a general rule is herewith presented, thought to be dependable, at least in the general locality wherein it was determined, and if conclusions above stated are correct, the rule should apply for other points as well. Observations upon the time of appearance of the insect in any of its stages could be made to supplement the general rule. The efficiency of the first two sprays suggested will largely determine the necessity of the later sprays. The dates given are those applying to the blooming and spraying of Jonathans at Fruita this year, and should be considered

as subject to variation with place, season, and variety. The egg observations were made upon trees receiving no treatment throughout the season.

HOW TIME TO SPRAY WAS DETERMINED IN EXPERIMENTAL ORCHARD.	TIME TO SPRAY—GENERAL RULE.
Petals dropped—calyces open ..... May 11	
First spray ..... May 11	(1.) Petals off-calyces open.
First eggs seen ..... May 21	
Numbers eggs seen ..... June 1	(2.) (*a*) One month from full bloom. (*b*) Three weeks from center calyces closing. (*c*) When apples are about ¾ in. diameter.
Second spray ..... June 2	
First generation, eggs maximum ..... June 13–19	
First generation, eggs minimum ..... June 28	
Second generation, eggs begin ..... July 2	
Third spray—(suggested) ..... July 2	(3) One month from (2)
Second generation, eggs abundant ..... July 17	
Fourth spray—(suggested) ..... July 18	(4) Two weeks from (3)
Second generation, eggs maximum ..... July 25–31	
Fifth spray—(suggested) ..... August 1	(5) Two weeks from (4)
Second generation, eggs diminished to about ..... Sept. 1	

The time in which an orchard must be completed with the first spraying will be of greater importance than the time required for second or other later sprays. Power spraying outfits make it possible to cover larger orchards in less time than with hand apparatus, but it has been found that under ordinary conditions one good power outfit should not be expected to cover more than twenty acres of full-bearing orchard at the first codling moth spray.

In apple orchards of mixed varieties those blooming first should be sprayed first. Pears do not close their calyces as quickly as apples, and their first spraying may be longer delayed.

Kind of Spray—The experiments of the year demonstrated that Swift's arsenate of lead was slightly superior to the arsenite of lime so far as killing effect upon worms was concerned. The difference seemed to be less than 4 per cent, but though the cost of the lead is considerably more, it is probable that with a heavy yield of fruit of high market value the lead would probably more than pay for the difference in cost. It is more convenient and less liable to injure foliage. Other brands of arsenate of lead were used with nearly equal success in controlling the worms, but some samples had been improperly made and caused injury to foliage and fruit from an excess of free arsenic contained. Arsenite of lime, used with sufficient lime, will

cause no injury to trees under ordinary conditions, though it is more liable to do injury than properly made lead arsenate. Injury to trees from arsenical sprays is more or less dependent upon variety of fruit and meteorological conditions at time of or following spraying. A practice among some orchard men the past season in Mesa County has been to use arsenate of lead for the first and second sprays, and if further spraying is found necessary the cheaper arsenite of lime is substituted.

Arsenate of lead was used at the rate of 12 pounds paste per 200 gallons of water in the experimental orchard.

Arsenite of lime was used at the rate of 1 pound arsenic, 4 pounds sal soda, 30 pounds lime per 200 gallons of spray, the arsenic and sal soda being boiled together in a small quantity of water for fifteen minutes until dissolved, after which the lime slacked with water to form a milk was added.

Both arsenate of lead and the arsenite of lime sprays, from their white coating upon the leaves, produce a shading effect, which in our arid climate serves a secondary beneficial effect by reducing transpiration by the foliage.

Method or Way to Spray—In the experiments of the year it was shown that the method of application had more to do with success than a difference of the insecticides used. The variation between poor spraying and very good spraying might well vary between 20 per cent and 98 per cent, while, as shown, the two insecticides showed variation of only about 4 per cent.

For the 12-year-old apple trees in the experiment at Fruita, an average of 12.9 gallons of spray was applied per tree for the first spray, and 9.9 gallons were used for later ones.

For the early spraying a coarser spray of liquid, such as would be given by a Bordeaux nozzle or a coarse Vermorel nozzle cap, is desirable. At this spraying the tree should be drenched with a strong, driving, coarse spray. It should be directed straight into the calyx cups that a maximum amount of poison may be placed in position there. It was determined by actual count that at spraying time average apple trees had two-thirds of their blossoms pointing in an upward direction and one-third in a downward direction. It is, then, apparent that spray must be directed downward upon the tree as well as upward through the branches. It was found necessary with full-bearing trees, in order to insure thorough work, that spraying be directed downward from the top of a tower constructed over the spray wagon. Where power outfits are used, and where the rows are of such a distance apart that the inner halves of any two can be treated from a point midway, it will be found that on medium to large trees two men upon the tower and one man spraying upward from the ground will be found most satisfactory. Spray poles eight to twelve feet long should be used by both ground and tower men. In one of the experimental orchards the height of tower man's reach was twenty-five feet above the ground.

For the later sprays, a nozzle producing a fine mist is desirable. A nozzle of the double-vermorel type, arranged in such a way that the direction of the nozzle can be placed at any angle with the spray pole, is wanted. The size of aperture wanted in the nozzle cap will depend upon the pressure maintained. The higher pressures can be directed through larger apertures and still produce a fine a spray. Higher pressures economize upon material and time and under ordinary conditions are most desirable.

In the experiment conducted upon the orchard of Mr. G. W. Marchant, of Fruita, two sprayings with Swift's arsenate of lead (1 pounds per 200 gallons) applied at the times indicated in the above table, and in a thorough manner, produced 98 per cent winesap, 95. Ben Davis, and 91.8 Jonathan apples free at picking time from a worm holes. Picked, unsprayed Jonathans in a block in the same orchard gave only 43.1 per cent free from worm holes, and 49 per cent of the apples, by actual count, originally borne by the trees, had fallen to the ground, 96 per cent wormy before picking. Only 1 per cent of the total crop of sprayed Jonathans fell to the ground as windfalls, and 74.1 of these were perfect apples. The apples in the sprayed plats were treated with a repetition spray following a heavy rain, though by comparison with plats left untreated with such spray it was found that the additional or repetition spray was unnecessary.

The complete details of this summer's experiments and observations upon the codling moth will be available in a special bulletin issued by the Colorado Agricultural Experiment Station, which bulletin is now under preparation.

HOWARD SCALE. (*Aspidiotus howardi Ckll.*)

This pest is one of greatest importance to the pear growers parts of Colorado. Besides the pear, it is known to infest prun plum, apple, almond, and certain shade and forest trees.

The life history of the insect was partially worked out during t year and experiments conducted showed the insect to be possible cheap and complete control by spring applications of the lime a sulfur wash.

As a bulletin is also soon to be issued upon this pest and its re edies, based principally upon this season's investigations, details of t work on the insect may be ommitted in this general report.

PEACH TWIG-BORER. (*Anarsia lineatella* Zell.)

Introductory—Experiments conducted at Palisade have demo strated the great value of arsenate of lead against the twig-borer the peach, which caused considerable damage to the peaches in this a other localities of Western Colorado.

Former recommendations for the control of this insect have b for spring applications of lime and sulphur washes. This has in f been a most successful treatment, but the use of lead arsenate agai the twig-borer of the peach is destined to meet with equal popular when its efficiency, cost, and convenience of preparation and applicat are considered.

The peach twig-borer is one of the most important pests to the peach growers of Western Colorado. All of the peach spraying carried on in the Grand Valley the past spring was directed against either the peach aphis or the peach twig-borer.

It is estimated that this pest cost the peach growers of California over a million dollars in the four years following 1898. To the growers of Grand Valley it has cost much loss for some years past, and its distribution on the Western Slope of the state seems to be quite general wherever peaches are grown.

Life History and Injury—The injury is caused by a small pinkish brown worm, with black head, measuring, when fully grown, about one-half inch long. The worm is the larval or immature stage of a small greyish moth.

The winter is passed by the larvae, still very minute, in small chambers hollowed out within the spongy tissue of the bark at the crotches of small limbs. The chamber is lined with silk of the larva's secretion, and the only evidence of the presence of the chamber is in a very small and inconspicuous heap of frass or peach-wood dust standing outward from the mouth of the burrow. Early in the spring, at about the same time the foliage of the peach shows as small green tufts upon the twig tips, the larvae leave their burrows and attack the tender twigs, boring into them near their tips and down through their pitch, forming galleries from one-third to one and one-half inch in length.

Examinations of infested peach trees at Palisade last spring showed these bored twigs wilting and turning brown early in the month of May. Later in the season, twigs bearing half a dozen leaf tufts near their tips would have each bored and killed and from all appearances by the same larvae. This injury to the terminal twigs constitute an important injury to the tree. Young peach trees are usually worst infested, their growth being sometimes greatly retarded.

On the 18th of May a number of larvae were taken in peach twigs at Palisade and kept in water in a closed cage at my insectary. An examination of the cage May 24 showed that two of the larvae had already changed to brown chrysalids or pupae, both emerging on May 28.

On May 20 many larvae were also found concealed about the base of the tree at the surface of the earth and hiding about the bark, and it seems that at this date the majority of the larvae, which hibernated over winter in the small bark cavities, have now completed their feeding on the twigs and are descending for pupation. As stated, the usual habit of the first or hibernating brood of larvae is to burrow into the twigs. A few instances were found, however, where small peaches, still no larger than a pea, were burrowed into, leaving the fruit with a hollow cavity within.

The small second generation worms were seen beginning their work early in June. It is this generation which brings about another and by far the greater amount of injury to the peach crop. Larvae from this generation make their way directly into the forming peach

itself, and the "gummy" peach is the result. Projecting bits or masses of exuded gum appear on the surface, and from their appearance and impaired keeping qualities they are rendered unfit for market. Some peaches containing larvae of the twig-borer find their way into boxes to be marketed on account of having the borer deep in the peach or within the pit without external signs of habitation. Such fruit, however, is first to soften and decay, and should be excluded, if possible.

Control—At Grand Junction last spring I received many inquiries from peach growers as to the best measures of twig-borer control.

So far as published accounts were available, contact insecticides, such as kerosene emulsion or lime and sulfur wash, were the ones considered most effective. The previous spring Mr. Frank Berger, of Palisade, and a few other growers of that place, had used arsenate of lead as a spring spraying, instead of the lime and sulfur wash ordinarily used, and reported no injury from twig-borer following. As none of these orchards had portions left with no spray, I could not determine for certainty whether the favorable results reported by these orchardists was due to the effectiveness of the spray or to the lack of original infestation by the twig-borer.

To determine this it seemed necessary to prove the value of the arsenical spray by an experiment carried on in an orchard where a considrable portion was left untreated, which was done in the five-year-old peach orchard of ninety-two trees belonging to Mr. S. L. Carson, at Palisade, where a portion was sprayed with arsenate of lead, another with the lime and sulfur wash, and a third part left with no spray. The arsenate of lead was used at the rate of 5 pounds of the paste to 50 gallons of water. The lime and sulfur wash was used at the rate of 15 pounds lump lime and 15 pounds flowers of sulfur per 50 gallons of water, the two ingredients being boiled together in a small amount of water for forty-five minutes, then diluted with enough cold water to make fifty gallons of spray. The spraying was done with a hand pump and sprayed trees thoroughly coated over all bark and twig surface. The two sprays, as applied, were of about equal cost—each a trifle over 1 cent per gallon, exclusive of cost of preparation. The arsenate of lead spray was far less inconvenient, and was quicker in preparation, and was also more pleasant to prepare and apply.

The spraying was done on April 14, at which time the majority of the blossom buds showed their pink tips, but as a rule were unopened, with the essential parts of the blossom still concealed by the folded petals of the flower. Some varieties, however, in each plat were farther advanced and some with as many as 87 per cent of the blossoms open.

The comparative insecticidal values of the two sprays were apparent through the season from the number of injured twigs per tree, and also from the number of gummy peaches per tree occurring upon each plat.

A striking difference was apparent when the number of injured twigs per tree were brought into comparison by observations made in May and shown in the following table:

A COMPARISON BETWEEN LIME AND SULFUR WASH AND ARSENATE OF LEAD AGAINST PEACH TWIG-BORER.

Spray.	Date Sprayed.	No. trees sprayed.	No. trees examined.	Date examined.	Total No. injured twigs counted.	Average No. injured twigs per tree.	Per Cent. Benefit.	Conclusions.
Lime and Sulfur....	14 Apr.	38	17	9-18 My	72	4.23	90	Good.
Arsenate of Lead..	14 Apr.	36	16	"	20	1.25	97	Better.
Check	No spray	18	8	"	342	42.75	0	

Circumstances prevented the keeping of an exact record of the number of wormy peaches taken from each plat, but a very noticeable difference was noted at time of picking—a difference quite as marked and corresponding in results with the figures shown in the above table. In fact, the owner of the orchard invariably picked the wormy peaches from the plat not treated and found scarcely any fruit damaged in either of the plats sprayed.

It may be said that arsenate of lead, applied in the spring at the time the buds of the peach are beginning to open, will control the peach twig-borer as effectually and cheaply as the lime and sulfur wash, up to this time the most universally used.

Any arsenate of lead spray applied to peach trees must not contain free arsenic, as they are easily damaged by impure lead or lead diluted with water to contain too high a per cent of the poison, though pure. Growers using 3 pounds lead per 50 gallons water were equally successful, and from the susceptibility of peach to injury, this latter strength is recommended, instead of the stronger spray used in the experiment reported above.

PEACH-BORER. (*Sanninoidea exitiosa* Say.)

Distribution—This dangerous insect has been found present in some peach orchards of the Western Slope.

Our species is the same as the one found in Eastern states, causing such widespread damage to peach trees. It is evidently a pest which has come into the orchards along with nursery stock brought to us from some infested part of our country

Injury and Life History—The injury is one resulting from the burrowing of a yellowish-white larva, which, when fully grown, sometimes measures one and one-fourth inches in length. Signs of the presence of the borer are the gummy exudations coming from the crown of the tree at the top of the ground. Infested trees examined early in the summer showed larvae of sizes varying from one-fourth to one and one-fourth inches in length. Some small larvae were then barely concealed beneath the peach gum on the outer bark.

Other larger larvae were within extensive chambers. extending up and down through the wood. sometimes an inch beneath the bark. Trees badly infested are completely girdled and killed. The insects spend the winter as larvæ, and in the early summer change to pupæ within a brown cocoon or cell from seven-eighths to one inch long by one-fourth to five-sixteenths inch in diameter, usually projecting into or from the gummy mass at the base of the tree. The first pupa was found formed within these cocoons on the 15th of June, though the majority were being formed about the middle of July. The pupæ yield moths, the female of which are of a blackish-brown color, with partially transparent wings and a black body. circled at about the middle with a beautiful orange band. The males are smaller and more slender than the females and have a number of smaller, less conspicuous bands of yellow about the abdominal segments and with more nearly transparent wings. The first moths appeared on July 6, though the maximum number were not appearing until about August 11, a singular fact, since these moths are known to come out in greatest numbers in New York state and at Washington, D. C., from one and one-half to two months earlier in the season. Eggs are laid upon the rough bark about the crown of the tree. The eggs, when laid, are oval and of a brown color. Large numbers are deposited by each female. On August 6, a single female gave by dissection about 400 eggs, 250 of the number at that date being brownish in color and well formed, while 150 were white and still embryonic in nature.

Experiments Begun—Its importance made it seem advisable to test remedial measures, and various old and some new methods of combatting the pest were begun in June, and the final results are still pending.

Following are the measures under comparison in the experiment:

(1) Carbon bisulfide, 1 ounce per tree about crown.
(2) Tobacco dust, 2 pounds per tree about crown.
(3) Tarred felt and wire shields about base of tree.
(4) Lime dust, 2 pounds to 4 pounds per tree about base of tree.
(5) Dirt removed and larvæ removed by hand.
(6) Banking earth about tree's base.
(7) Tree washes.
(8) Trees not treated in same orchard to be used as comparison.

GREEN APHIS OF APPLE. (*Aphis pomi.*)

Importance—The unusual abundance of this aphid the past season upon apple and occasionally upon pear on the Western Slope has made it necessary to make observations upon and carry out insecticidal tests against it.

Life History—The green aphis winters as eggs upon the twigs of the tree, and the past spring a very large per cent withstood the winter. They began hatching about Grand Junction about April 1, continuing for two weeks or more. The young hatched at about the same time the first traces of green foliage appeared, and thus found tender food upon which to feed at once.

In the latter part of April winged insects appeared and a general spreading of the pest from tree to tree and orchard to orchard took place. Multiplication was enormously rapid. The injury continued to increase in severity through the summer. Lace wings and syrphus fly larvæ, as well as the adults and larvæ of lady beetles, served to do much good later in the season, but did not succeed in reducing the aphids enough to prevent great injury. Eggs of the green aphis were first found in the fall at Grand Junction on October 16. When first laid, the eggs are green, but finally turn to a glistening black.

Injury—They have been a great hindrance to the growth of young apple trees set the past spring or the preceding year, and older trees have not been exempt from their attacks. Missouri Pippin apples of all ages have suffered heavily, the aphis apparently preferring this variety to any other common in the Valley of the Grand. Badly infested trees through the summer present a most disgusting appearance, the aphids becoming so numerous that the whole tree assumes a sticky coating of the secretion from the bodies of the insect. This "honey dew" secretion attracts swarms of flies and ants, and the trees often emit a very disagreeable odor.

The effect upon the tree, if young, is a severe retarding of its growth. A form of injury noted this season, thought to be due to this insect, was an odd and greatly deformed growth of the fruit itself. Nero and Winesap apples were found affected in this way. The young apples, when only from one-fourth to one-half inch in diameter, had been so thickly covered with aphids that their growth had been suddenly checked. Later on, their growth had been resumed principally from the outer end of the apple, producing what might be called a "double apple," with a constriction at the middle point. Other apples were caused to grow in greatly gnarled or knotted forms. All were greatly dwarfed in size, seventeen Winesap apples at harvest time being contained, in one instance, within a common match box.

Treatment—Trees heavily infested had their leaves tightly curled, due to the presence of myriads of the aphids upon their under surfaces. With the aphids thus concealed within the curled leaves, it was found almost impossible to cover their bodies with any contact spray applied, and the practice of summer spraying against them was anything but a success. Individual trees were, in cases, cleared up, but other trees near by and left untreated usually very soon reinfested them.

Spring and early winter treatments were also carried out in experiments against this insect.

The spring spraying was directed against the eggs of the pest and gave the best promise of its successful control. In an experiment with a number of contact sprays applied April 5, just after the eggs had begun to hatch, it was found that the lime and sulfur wash proved the most successful. In this instance, 15 pounds of lime and 15 pounds of sulfur per 50 gallons of water were used, and practically all of the eggs and hatched aphids were destroyed.

In December, kerosene emulsion and soluble petroleum sprays were given egg-covered trees, and the per cent of eggs destroyed at time of hatching this spring will be determined. Further experiments for the control of this pest are planned, including a large series on contact insecticides to be used this spring.

WOOLLY APHIS. (*Schizoneura lanigera.*)

Importance—Probably more important to the fruit growers of Western Colorado than the green aphis is the woolly aphis of the apple. The past season this pest has ranked second only to the codling moth in destructiveness in the Grand Valley, and has been of first importance in other counties of the Western Slope.

Life History—Many lived through the winter upon the roots of the apples, and a few survived the winter upon the branches above ground. During the winter of 1905-06 the temperature at Grand Junction, according to the United States Weather Station, did not drop as low as the zero point, and the unusually mild winter perhaps had much to do in the great abundance of the insect this past summer.

In May many of the aphids above ground had already secreted their woolly coverings of white, and in cases heavily infested the water sprouts about the base of the tree. By the month of July, countless myriads of them were to be seen crawling over all parts of the tree and fruit, as well as upon the ground through the orchards. Winged ones were noted first at Fruita September 6.

Parasites—Parasites have done some service in helping to keep in control the pest, but have not been abundant enough to reduce the number of insects to a point below injury. Lace wing and syrphus-fly larvæ, as well as adults and larvæ of lady beetles, have been most prominent in preying upon this aphis. Some observations upon the habits and life history of these parasites have been made.

Injury—Roots and tops were attacked throughout the season, the twigs being sometimes entirely coated with the woolly secretion covering the bodies of the insects. Such infested twigs were greatly dwarfed, the bark on the twigs caused to split and grow in a gnarled and misshapen form. The "honey dew" secretion from the insects in some cases coated over the peeling of the fruit itself, leaving the surface so sticky and discolored that apples were disgusting in appearance and most unpleasant to handle. Grafts and top-worked trees suffered most heavily in the spring, and their injury continued through the summer.

So thick were the insects upon the branches that apple pickers working in the trees had their clothing covered with crushed bodies and the white secretion of the insect.

Roots about the crown of the trees were gnarled and knotted, resulting in the dwarfing of the trees, the production of undersized fruit, and, in exaggerated cases, the outright destruction of the trees themselves.

Experiments in Progress—Summer sprays, as with the green aphis, where the infestation was so severe and so general through the orchards, proved of small practical value.

This pest is of such importance that careful and exhaustive experiments of measures of control must be carried out against them without delay. In the fall and early winter a long list of insecticides were applied to infested trees, and the list will be duplicated this coming spring, and it is hoped that by the coming fall some practical suggestions upon an effective method of control of the pest may be reported. Tobacco and carbon bisulfide upon the roots of the trees, and kerosene emulsion, whale oil soap, and tobacco decoction sprayed upon the tree have been the previous practices of treatment by orchardmen. These measures, soluble petroleum sprays, tree tanglefoot bands and many other methods of control will be given thorough trial.

A NEW INJURY TO PEAR AND APPLE BUDS.

Description—On the 4th of May, an injury to buds of pear on grafts placed into pear stocks about one month earlier was observed. Attention to the injury had been called by the owner of the grafted trees, who had observed that his grafts, which should have been starting readily off into growth, were being held back by some insect, which apparently was eating away the buds as soon as they started to grow.

Examination on May 4 showed the injury to be caused by a tiny chrysomelid beetle (*Myochrous squamosus* LeC.) greyish-brown in color and less than one-fourth inch long. No published accounts of injuries of this kind from this beetle have been found, and it is probable that this observation of injury is the first recorded against the beetle. It caused enough trouble, however, to require some remdial measures. Unless something had been done greater damage would have resulted, and, as it was, some of the attacked grafts were destroyed by having all buds eaten away.

The beetles were discovered about the bases of the grafted pear trees, hiding beneath clods and in crevices of the earth. The principal injury was done to pear buds, though specimens were also taken feeding upon the buds of apple borne by twigs near the ground. Beetles were also found beneath clods about the apples. Not only did the beetles attack the buds upon grafts, but they were found eating into the pear leaf and fruit buds high up into the tree. In one instance, a beetle was watched eating away the petals of an open pear blossom. Search was made about the trees for a weed or plant which could have served as a natural food plant for either adult or larvæ, but none was found. As many as a dozen beetles were, in cases, collected about the grafts of a single small tree or about the base of the tree. The injury continued through the month of May, and beetles kept in cages at my insectary were kept alive through the month of June. Many of the beetles were found floating on the water in irrigating ditches late in May, and later adults were taken hiding beneath bands placed upon trees to capture codling moth larvæ.

Control—Several measures of control were suggested or used. A spray of arsenate of lead applied to the buds was tried and thought to have been of considerable benefit. The owner of the orchard prac-

ticed hand picking of the beetles, but the process would be entirely impracticable upon any number of trees. The winged beetle appeared to be more of a crawling insect than a flying one, which suggested the possibility of protecting young grafts by placing bands of "Tree Tanglefoot" or other adhesive bands about the tree trunks to keep the beetles from ascending in the spring.

MISCELLANEOUS OBSERVATIONS.

A great many other injuries to fruit or field crops by insects, rodents, etc., were observed through the season.

A pink-bodied aphis of undetermined species was found doing considerable damage to peach buds, blossoms, and young fruit early in the spring. Specimens were first seen April 13, at which time peaches were showing first bloom. The larger, flat-bodied, pinkish aphis first observed gives birth to young, which cluster about the blossoms and about the forming peaches, still very small, sucking from them the sap and causing many to fall to the ground. Later in the season, peach leaves are curled up by the aphids, but all seem to disappear late in May. The injury is thus done early in the season at the time fruit is setting. Application of the lime and sulfur wash just before the buds open is suggested as a means of control, and this and other measures of treatment will be tried in an experimental way the coming spring.

Observations were also made upon aphids infesting plums, elms, and poplar.

Injuries to cantaloupes were noted, caused by leaf miners, the common red ant of the prairies, and prairie dogs. In some orchards the green fruit worm caused injury to from 10 to 25 per cent of the young forming apples, but in orchards receiving proper codling moth spraying the injury is much less severe or reduced beneath notice.

A pear leaf blister mite, probably of a different species from that causing the injury in Eastern States, was observed in great numbers through the summer, causing the blackened curling of the pear leaves at the tip of the twigs, as well as producing minute blisters upon the leaves and causing them to drop from the trees prematurely. It is thought that a late spring spray with the lime and sulfur wash will also control this pest.

Other orchard pests observed, studied, or experimented upon in attempt at control were the buffalo tree hopper, tent caterpillar, hawk moth larvæ, grasshoppers, thrips, brown mite, pear and cherry slug, terrapin scale, Putnam scale, and numerous parasitic or predaceous insects doing beneficial service in the orchards.