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DIVISION OF ENTOMOLOGY.
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REPORTS

OF

OBSERVATIONS AND EXPERIMENTS

IN

THE PRACTICAL WORK OF THE DIVISION,

MADE

UNDER THE DIRECTION OF THE ENTOMOLOGIST.

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CONTENTS.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., March 25, 1893.

SIR: I have the honor to transmit for publication Bulletin No. 30 of this Division. It comprises the reports of the field agents of the Division for the past year (1892), a summary of which has been included in my annual report.

Respectfully,

C. V. RILEY,
Entomologist.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

REPORTS OF OBSERVATIONS AND EXPERIMENTS IN THE PRACTICAL WORK OF THE DIVISION.

INTRODUCTION.

The present bulletin is a continuation of the series of annual reports of the field agents of the Division, Bulletins 22, 23, and 26 of this Division comprising those for 1889, 1890, and 1891, respectively.

Mr. Koebele's continued absence in Australia up to the middle of the summer, and other duties connected with the closing up of his last Australian mission, have occupied his time to such an extent that no regular report from him is included.

Owing to the reduction in the appropriations for the Division, Mr. F. M. Webster, in Ohio, and the apicultural agent, Mr. J. H. Larrabee, in Michigan, were suspended from duty July 1, 1892. The former was immediately appointed entomologist of the Ohio Agricultural Experiment Station, and has made no report upon his operations as agent of the Division for the first six months of the year.

Mr. Larrabee, however, has sent in a somewhat full report upon the experimental work in apiculture, which is published herewith, and which will be found of interest to apiarists. Accounts of his experiments upon the important questions of cross-breeding, temporary removal of the queen to prevent swarming, the amount of honey consumed by bees in secreting one pound of wax, the cultivation of honey plants, and others, are included.

Mr. D. W. Coquillett, agent at Los Angeles, Cal., reports in full upon his experiments with the beneficial insects received from Mr. Koebele from Australia and New Zealand, giving detailed descriptions of the different states of the species brought over. He also treats of a span-worm (*Boarmia plumigeraria* Hulst), which has lately proved very injurious to Walnut in parts of California, and closes with some account of experiments against the Codling Moth and a few other insects which have been injurious to fruit trees in California during the year.

The Nebraska agent, Mr. Lawrence Bruner, reports upon the outlook for destructive locusts, but devotes the main part of his report to a consideration of certain sugar-beet insects, closing with a short summary of the miscellaneous injurious insects of the season.

The Iowa agent, Prof. Herbert Osborn, gives a general summary of the injurious insects of Iowa for the season of 1892, reports upon further experiments upon grass insects, and gives an account of certain tests made with the White Grub fungus of Europe against our American species.

The Missouri agent, Miss Mary E. Murtfeldt (who was also furloughed at the close of the last fiscal year on account of the reduction in the appropriation), gives in her report an account of certain insects which have been prominent in her vicinity during the season, bringing out, notably, an important point in the life-history of the Cabbage Curculio, and describing a serious attack upon Spinach by a small leaf-beetle.

C. V. R.

REPORT ON SOME OF THE BENEFICIAL AND INJURIOUS INSECTS OF CALIFORNIA.

By D. W. COQUILLETT.

LETTER OF SUBMITTAL.

LOS ANGELES, CAL., *November 3, 1892.*

SIR: I submit herewith my annual report for the year 1892. The major portion of this report consists of an account of the beneficial insects sent to me from Australia and New Zealand by Mr. Albert Koebele under your directions. The caring for these insects and the working out of the life history of the most important ones has consumed a large portion of my time during the past season. The present indications are that the *Orcus australasiæ* will prove of more benefit than any other of these recently introduced species.

Early in the season reports were received of the occurrence in destructive numbers of certain kinds of caterpillars or span-worms, in the counties of Santa Barbara, Alameda, and Santa Clara; and in accordance with your instructions I visited each of these localities, and spent several days in investigating these destructive insects. The species causing the damage in Santa Barbara County proved to be a kind of span-worm which had occasioned considerable injury to the leaves of English walnut trees; an account of this pest is given in the following pages. The principal depredator in Alameda and Santa Clara counties proved to be also a span-worm or canker-worm, closely resembling the well known Fall Canker-worm (*Anisopteryx pometaria* Harr.), but as the moths have not yet issued the species can not be determined at present, but will be reported upon later.

The Fluted or Cottony-cushion Scale (*Icerya purchasi* Mask.), is still held in subjection by the *Vedalia cardinalis*. Since sending in my last annual report I have, at your instance, sent colonies of this useful insect to New Zealand, South Africa, and Egypt, besides sending a large number of colonies to various parts of this State.

The treatment with hydrocyanic acid gas is coming into more general use and continues to be the most effectual remedy at present known for the extermination of the various kinds of scale-insects. The sheet fumigator, described in my letter to you of March 18, and published in the June number of INSECT LIFE, is more widely used than any other kind, being less expensive and easier to operate than those heretofore in use. During the present season the supervisors of Los Angeles County instructed Mr. John Scott, the horticultural commissioner, to purchase seventy tents and the necessary chemicals, and to fumigate the infested trees at cost to the owners. The city of Riverside has also purchased a large fumigating outfit with which to exterminate any scale-insects that may be introduced there, and the citizens of Anaheim, in the adjoining county of Orange, have also purchased a fumigating outfit and have treated nearly all of the infested trees in that vicinity. From the States of Louisiana and Florida I have received letters in relation to this treatment, and

the entomologist of the experiment station in the former State, Mr. H. A. Morgan, recently wrote me that he was making preparations to test it on certain kinds of scale-insects infesting orange trees in his State.

As in former years, I am greatly indebted to you for numerous favors, especially in the matter of identifying insects, for all of which please accept thanks.

Very respectfully yours,

D. W. COQUILLETT,
Special Agent.

Dr. C. V. RILEY,
U. S. Entomologist.

BENEFICIAL INSECTS IMPORTED FROM AUSTRALIA AND NEW ZEALAND.

At the last session of the legislature of this State the sum of $5,000 was appropriated for the purpose of importing from foreign countries beneficial insects that would prey upon the injurious ones found in the State, and this sum having been placed at the disposal of the Secretary of Agriculture at Washington, D. C., Mr. Albert Koebele, one of the agents of the Division of Entomology, was sent on this mission, with instructions to collect specimens of all kinds of beneficial insects and forward them to the writer for propagation and distribution. A large portion of my time has been consumed in caring for and working out the life histories of the insects thus received. Many of the species originally preyed upon insects not found in this State, and much time was spent in testing them with the different kinds of injurious insects found here, in the hope that they could be induced to feed upon them. Eight separate consignments were received at intervals of four weeks, between October 30, 1891, and May 14, 1892. As the majority of these were received during the rainy season, I had three cloth tents erected over as many infested orange trees, the better to protect the insects from the inclement weather.

The first consignment of these insects, collected in the vicinity of Auckland, New Zealand, was received on the 30th of October, 1891, and consisted of two living adult specimens of *Leis antipodum* Muls. and one adult and seventy larvæ of *Scymnus flavihirtus* Brown. The body of this larva is black, and is rather sparsely covered with very short, blunt, white bristles; on each side of the body are several prominent bristle-bearing warts, the three low down on each side of the fourth, eighth, and ninth segments, and also the two on the eleventh segment, being white, the others blackish; the upper one on the eighth and ninth segments is smaller than the others; the head and thoracic legs are dark brown; length 3 mm. The pupa is entirely greenish-yellow, and the old larval skin is worked backward until it covers only the extreme end of the pupa. In the same box with these larvæ were leaves infested with a Coccid which is apparently the *Ctenochiton depressum* Mask., a species thus far known to occur only in New Zea-

land. I tested the above larvæ with specimens of *Aspidiotus aurantii* Mask. and with *Lecanium hesperidum* Linn., and they fed sparingly upon them. The next day I placed these larvæ and the adult specimen upon a tree thickly infested with the Lecanium; this tree I have examined at intervals, but at the last examination did not find any of these ladybirds in any of their stages either upon this or any of the adjacent trees. Still, it is possible that they are established here, but in such small numbers that it is difficult to find them, the insects also being small and inconspicuous.

The two specimens of *Leis antipodum* received with the above I tested with several different kinds of scale-insects, but they did not appear to attack any of them and died on the 20th of the following month without having deposited eggs. All of the other insects which came in this consignment were dead when I received them.

With the above consignment was received, October 30, 1891, the following letter, dated Auckland, New Zealand, October 8, 1891:

By this steamer I send a number of Scymnids, several species, and but two single *Leis antipodum*, which I wanted very badly.

I think it would be a good idea to feed them up at first in large glass jars with *Lecanium hesperidum* and Red Scale; but do as you think best, yet let the insects have light and air besides food,

Please write to me how they arrived and what they feed upon. Let me particularly know about the *Leis*, should they arrive living. Give them *Lecanium hesperidum* and *L. oleæ*. I think they will feed on these, if anything.

As it looks, these little beetles have not much of life in them; they are probably hibernated insects, and through with life; yet the larvæ may be all right. I hope for the best.

Am very well at present and hope to do much better by next steamer. It is too early here as yet, and Sydney I will find warm, if not already hot.—ALBERT KOEBELE.

Under date of November 3, 1891, I wrote to Mr. Koebele, giving an account of the condition of the insects when received by me, and advising him to always pack the insects in Sphagnum moss, as those packed in this manner had reached me in much better condition than had those packed in paper cut into fine strips. As there was no address given in his letter, I simply addressed my letter to him at Auckland, New Zealand, but in the month of May of the following year it was returned to me by the post-office officials, having for some reasons failed to reach him.

The next consignment of insects reached me on the 28th of November, 1891, and the boxes, with the single exception of one from Sydney, Australia, were marked as having been filled at Parramatta, Australia, between the 23d and 30th of October, 1891. With this consignment was received the following letter, dated Sydney, Australia, November 1, 1891:

You will receive by Wells, Fargo & Co. a lot of insects, all Coccinellidæ. Please select an orchard badly infested with the Red Scale, and also some Black Scales, as many of the things feed on this as well as *Lecanium hesperidum*. Turn all the things loose in such an orchard. There are plenty of them to start with.

The large red and black spotted Coccinellid is *Leis conformis*, feeding upon Aphids, which I fear you will not have now; but I send a lot of this to San Francisco to be placed in apple orchards infested with the Woolly Aphis. You will find two boxes with eggs of the little blue beetle. Place them upon trees with Red Scale. This is and will prove to be the best remedy for that scale I shall be able to send. The large blue beetle with orange spots also feeds on this scale. And as to the Scymnid, I have marked upon boxes what they feed on: all the smaller upon *Aspidiotus aurantii*, and one box contains about 90 or 100 of one species found, as yet, feeding only upon a species of Chionaspis, upon a Banksia.

Make preparation, and as soon as the box arrives take them into the field and liberate the insects. A short delay would be death to many of them.

I will run up to Queensland, but will be here again to make up another sending of these beetles for next steamer.—ALBERT KOEBELE.

This consignment contained the following living insects: Four specimens of *Orcus chalybeus*, five of *Orcus australasiæ*, and six specimens of an undetermined Scymnid. All of the other insects, including the eggs and larvæ, were dead when received by me. I tested the living insects with specimens of *Aspidiotus aurantii*, and they fed upon them. Not being willing to turn such a small number of insects loose, as was suggested in the letter, I had a cloth tent erected over an orange tree thickly infested with the above-mentioned scale and placed all of the ladybirds on the tree under this tent. This tree was kindly placed at my disposal by Mr. A. F. Kercheval, of this city.

The next consignment reached me December 28, 1891, accompanied by the following letter, dated Sydney, Australia, November 29, 1891:

Be ready for a large lot of specimens coming per Wells, Fargo & Co. Liberate them in same place as you did the last so they can find each other. Of the two *Orcus* you will receive large numbers; inclosed some of *O. australasiæ* in box with *Lecanium oleæ*, where you may find eggs; also, *O. chalybeus* and a large black Scymnid, which has been, as yet, found only on *L. oleæ* and *L. hesperidum*.

* * * Box "*Vedalia* sp., Toowoomba, Parramatta." Try and breed this little beetle on Icerya. It is the insect destroying this scale here and at Queensland. They will readily lay their eggs in a large glass jar if supplied with scales. You will also get a large lot of *Thalpochares cocciphaga*, both larvæ and pupæ. *Do not set them free*, but breed in confinement in large glass jars covered with muslin and well supplied with *L. oleæ*. * * *

Please save all the boxes with dead insects for me, as I shall want them for future notes. Of course you can have specimens for collection if you should want them. I may now wait in sending future lots of Orcus until I hear from you how this arrived. It is not possible that all should die.

It would be a good arrangement to have three jars for the *Thalpochares*—one to feed the smaller larvæ, one for pupæ, and a third with plenty of fresh food to place the moths in as they appear. The sticks with scales could be taken out from time to time and fastened onto orange trees infested with the scales in the field.

I think that these larvæ attain their growth in from three to four weeks. They are a stupid lot, always spinning everything together. Therefore it would be well to give them plenty of room.

The larvæ of Orcus could be got by the thousands, but I can not send any on account of the parasites.—ALBERT KOEBELE.

In this consignment were the following living insects: Three specimens of *Orcus chalybeus*, one *Orcus australasiæ*, eleven undetermined

Scymnids, one hundred and seventy-five specimens of *Alesia fromata*, twenty-four specimens of a large, reddish-yellow Coccinellid having six irregular spots besides the elytral suture black, three specimens of *Novius kœbelei*, twelve small black ones having a large red spot on each elytron, twenty-two specimens of a black Scymnid having only the apex of the abdomen red.

I tested them with a great variety of different kinds of insects, and ascertained that the Alesia—the yellowish one with six elytral black spots—the Cryptolæmus, and the black one with two elytral red spots, all fed upon the Cabbage Aphis (*Aphis brassicæ*). Accordingly, I turned them loose in a field of cabbages thickly infested with these Aphides. The Novius I placed in a jar containing Iceryas; the remaining specimens I placed on the orange tree under the tent where I had placed the previous consignment.

On the 30th of December, 1891, I wrote Mr. Koebele as follows:

The two packages of insects which you sent me from Sydney reached me in very poor condition. In your first sending were only four living *Orcus chalybeus*, and in the last sending three. Of *Orcus australasiæ*, five were alive in the first lot, but only one in the last. As these are the two species that we look to for ridding the infested trees of the Red Scale, it would be well to pay especial attention to them in your next sending. Try especially to send the pupæ, as these withstand the voyage better than the adult beetles. The square boxes with sliding lids are better for sending them in than are the smaller circular ones. I noticed that those packed in Sphagnum moss came through in better condition than those you packed in paper cut into strips. A good plan would be, to place in the bottom of the box a thin layer of damp Sphagnum, then twigs infested with the scales, after this the ladybirds, placing on the top another thin layer of Sphagnum.

Packages intended for me should be addressed to me at 236 Winston street, so that the express company will not have any difficulty in delivering them.—D. W. Coquillett.

The next consignment of insects reached me January 23, 1892, and was accompanied by the following letter, dated Sydney, Australia, December 28, 1891:

A lot more of Coccinellids, to be let loose in same place as previously. Also a number of things in one box, to breed in confinement. Do not open boxes outside of room or with open windows. The parasites will not only destroy these larvæ, but all or any Coccinellid. I hope you see the point, and I trust to you not to let any escape. Also, more larvæ and pupæ of *T. cocciphaga*. Feed Coccinellid larvæ from Whitton on Lecanium, as also those of *O. australasiæ*.

Why did you not write about the New Zealand insects?—Albert Koebele.

In this consignment were four hundred living adults of *Orcus chalybeus*, seventy-five of which I placed on the orange tree under the tent, and liberated the remainder in the orange grove adjoining this tree, this grove being very thickly infested with *Aspidiotus aurantii*. The consignment also contained forty-five adults and thirty-six living pupæ of *Orcus australasiæ;* twenty-two of these I placed on the orange tree under the tent, while the balance were placed on an ash tree thickly infested with *Lecanium oleæ*. I retained the pupæ in my office until

the beetles issued, then placed the latter on the ash tree above mentioned. Besides these, there was also a package of twigs on which were numerous specimens of *Lecanium oleæ* infested with a fungus; these I placed on an oleander bush thickly infested with the above-mentioned Lecanium. The package also contained eight large black Scymnids, which fed sparingly upon *Lecanium oleæ*, and I therefore had a tent erected over an orange tree thickly infested with these scales, and placed the Scymnids in this tent. This tree was placed at my disposal by Judge E. Silent, of this city.

I received the next consignment on the 20th day of February, 1892. It was not accompanied by any letter. The entire package was completely soaked with water when it reached me, and several of the boxes were broken open. This consignment contained eight living adults of *Orcus chalybeus*, which I liberated in the same orange grove where I had placed those of the previous sending; twenty-three Scymnids, which I placed on the orange tree infested with *Aspidiotus aurantii*, under the tent, and thirty adults of *Orcus bilunulatus*, which I placed on the orange tree infested with *Lecanium oleæ* under the tent at Judge Silent's.

The next package of insects reached me on the 21st of March, 1892, and was accompanied by the following letter, written at Sydney, New South Wales, February 22, 1892:

> I have your letter of December 30. Sent a lot more of Orcus and a small Scymnid on Red Scale; this latter is as good as Orcus in destroying these scales.
>
> In box with Eriococcus you will find some Scymnids feeding on Black Scales, also their larvæ, larvæ of Thalpochares and of a Pyralid (?). This latter you had before. They may feed on Lecanium. Breed all these in confinement, and not get box near Eucalyptus. A whole box full of Lecanium with internal parasites. You had better not place them on trees, but at a distance from them, as, if necessary, in case the Scales should establish themselves, they could be promptly destroyed. The same may be said of the Eriococcus, which, although only feeding on Eucalyptus, is a bad thing on these trees.
>
> Await *Leis antipodum* and rear on *Lecanium hesperidum*.—A. KOEBELE.

This package did not contain a single living insect when I received it. Among the dead insects was a ladybird larva which I recognized as belonging to *Scymnus lophanthæ* Blaisdell, a species which had evidently been imported into this State from Australia several years ago, and upon procuring specimens of the larvæ of this ladybird from orange trees in this city I found that the two forms were identical. The package also contained dead specimens of a ladybird which agree in every particular with specimens of the above-named Scymnus contained in my collection and which were captured in this city several years ago. Specimens of both were submitted to Dr. Riley in order to settle this question definitely, and he writes me that the two forms, the one received from Australia and the other collected in this city, are indistinguishable, and that both belong to the species recently described by Dr. Blaisdell as *Scymnus lophanthæ* (see "*Entomological News*," vol. III, p. 51). I gave a description of the larva and pupa of this ladybird in

Bulletin No. 26, Division of Entomology of the U. S. Department of Agriculture (pp. 16 and 17), where it is referred to as "an undetermined species of Scymnus, closely related to *Scymnus marginicollis* Mann., but having a distinct metallic, somewhat brassy tinge upon the wing-cases." I have found this larva feeding upon the Red Scale (*Aspidiotus aurantii*) as well as upon the San José Scale (*Aspidiotus perniciosus*) and the Woolly Aphis (*Schizoneura lanigera*). This is doubtless the "small Scymnid on Red Scale" referred to by Mr. Koebele in the letter given above and which he says is "as good as the Orcus in destroying these scales," the other Scymnids referred to being much larger species.

Another package of insects from Sydney, Australia, was received on the 15th of April, 1892. No letter accompanied this package, which contained the following living insects: Twenty-seven specimens of *Orcus chalybeus* and nine of *Orcus australasiæ*, all of which I liberated in the orange grove in which the former consignments were set free; four specimens of *Leis conformis*, and five of the large yellow Coccinellid with six elytral black spots, which was also represented among those received December 28, 1891, and alluded to above. The specimens of the last two species I placed on an orange tree thickly infested with Aphides. There was also a box containing a number of larvæ and chrysalides of the moth *Thalpochares cocciphaga* in their cocoons; these I placed in breeding cages in my office and kept them well supplied with *Lecanium oleæ*. During the month of May nine adult parasites belonging to the genus Bracon issued from these larvæ or chrysalides. The moths issued in the latter part of June and during the month of July, and after the last one had finished depositing her eggs I placed the entire contents of these cages in an orange tree thickly infested with *Lecanium oleæ*.

The eighth and last consignment of insects from Sydney, Australia, reached me on the 14th of May, 1892. This package also was not accompanied by letter. For the first time, all of the insects had been packed in Sphagnum moss, as advised in my letter to Mr. Koebele, of December 30, 1891, a copy of which is given on a preceding page, and the insects reached me in much better condition than did those of any previous sending. This package contained 560 living specimens of *Orcus chalybeus*, 20 *Orcus australasiæ*, 170 specimens of *Leis conformis*, and 5 specimens of the yellow Coccinellid with six elytral black spots. I retained 20 of the *Orcus chalybeus* and 10 *Orcus australasiæ*, for breeding in my office; the remainder I turned loose in an orange grove, in this city, thickly infested with *Aspidiotus aurantii*, *Lecanum oleæ*, and a certain kind of *Aphis*. The specimens of *Leis conformis* I liberated in an apple orchard, in this city, thickly infested with the Woolly Aphis (*Schizoneura lanigera*), while the yellow ladybirds with six elytral black spots were kept in my office, in a large glass jar well supplied with Aphides. On the 28th of May a parasitic larva issued from the under part of the body of one of the last-named ladybirds, and spun its tough brownish cocoon beneath the latter, thus attaching the ladybird to the surface upon

which it rested, and the adult fly issued from this cocoon eight days later. On the 30th of May another parasitic larva issued from a second of these ladybirds, and spun its cocoon as the previous one had done, and the winged parasite issued seven days later. I submitted both specimens of this parasite to Dr. Riley for identification, and he writes me that they agree in every particular with specimens of *Euphorus sculptus* Cr. in the collection of the National Museum. It is interesting to note that on page 57, volume III, of INSECT LIFE, Dr. Riley records having bred this same species from adults of the native ladybird, *Megilla maculata*, collected at Washington, D. C., and also at La Fayette, Ind.; while here in California I have bred what he pronounces to be this same species from two of our common ladybirds, *Hippodamia convergens* and *Coccinella sanguinea*, both of which are also found in the eastern part of this country. Thus this parasite is known to occur on both sides of this continent as well as in Australia. With the above-mentioned package was received a box of *Aspidiotus aurantii* infested by a fungus; these I placed in an orange tree thickly infested with this kind of scale-insect.

As stated above, no insects were received by me from Mr. Koebele later than the 14th of May, 1892.

The following are my notes and descriptions of the early stages of some of the insects received from Australia. These are not complete in regard to all of the species, since a sufficient number of specimens of several of the species was not received to permit of my making descriptions of all the stages, and I was unwilling to hazard the life of any of the larvæ belonging to species not thoroughly established here by submitting them to repeated and critical examinations such as it would be necessary to make in order to describe the various stages through which these insects pass:

ORCUS AUSTRALASIÆ.—*Egg.*—Elongate-ellipsoidal, two and half a times as long as broad, polished, but slightly scabrous, one end bearing numerous minute tubercles; color, light lemon yellow; length, $1\frac{1}{2}^{mm}$. Deposited beneath dead, empty specimens of *Lecanium oleæ* partially raised from the surface upon which they rest; usually deposited in pairs, the eggs being attached at one side to the under surface of the scale.

Time from deposition to hatching, eighteen days.

Larva.—First stage.—Body brownish black; first segment encircled in front and on the sides with a row of fourteen small tubercles each tipped with a single bristle, except two of the lateral ones each side, each of which bears two bristles. There is also a pair of smaller subdorsal bristles near the posterior end of this segment; second segment bearing twelve tubercles, arranged on each side of the segment, one subdorsal, three suprastigmatal arranged in the form of a triangle, and two stigmatal tubercles placed one in front of the other, the anterior of these being much smaller than the posterior one, and destitute of a bristle. Each of the other tubercles bears a bristle which is more than twice as long as the tubercle itself, except the anterior of the three arranged in the form of a triangle. This bears two bristles; one, which is shorter than the other, is inserted below the apex on the front side, at which point this tubercle bears a minute branch; third segment like the second, except that the upper of the three tubercles in the triangle is wholly wanting, leav-

ing only ten tubercles on this segment; fourth segment bearing a tranverse row of six tubercles, the subdorsal ones each bearing two bristles, the second of which is inserted below the apex on the front side; each of the suprastimatal tubercles bears three bristles, two of which are inserted below the apex, one on the front side and the other on the outer side; the lowest tubercle bears but a single bristle; fifth to tenth segments, like the fourth; eleventh segment like the fourth, except that the lowest tubercle on each side is wanting, leaving only four tubercles on this segment; twelfth segment destitute of tubercles; head wholly black.

Duration of this stage, six days.

Second stage.—Body brownish black, a yellow dot on the posterior margin of the first segment; a larger medio-dorsal yellow spot on the second, third, seventh, and eighth segments; tubercles black, except the posterior four or six on the first segment, all of those on the second, all except the lowest ones on the third, all on the seventh and eighth, and all except the lowest on the ninth segment, which are largely or wholly yellow; sometimes, however, the lowest tubercles on the second, seventh, and eighth segments are black; first segment encircled in front and on the sides with a row of sixteen long tubercles, each of which bears a long apical and several shorter lateral bristles; there is also a small, yellow subdorsal tubercle each side of the middle, near the posterior end of this segment, each tubercle bearing a bristle which is three times as long as the tubercle itself; other tubercles arranged as in the first stage, each bearing an apical and several lateral bristles, the apical one not appreciably longer than the tubercle itself, except in the case of the tubercles situated lowest down on each side of the body; the anterior of the two lowest tubercles on the second segment is scarcely more than half as long as the posterior one; the anterior of the two lowest tubercles on the third segment is minute and scarcely apparent; head entirely black.

Duration of this stage, seven days.

Third stage.—Marked as in the second stage, except that all of the tubercles on the ninth segment and the subdorsal ones on the tenth are yellow; tubercles arranged as in the second stage; the subdorsal tubercles near the posterior end of the first segment are now much larger, being scarcely shorter than the bristles at their apices; the anterior of the two lowest tubercles on the third segment is scarcely one-sixth as long as the posterior one, and is yellow; the four tubercles on the eleventh segments are noticeably longer than any of the others.

Duration of this stage, eleven days.

Fourth stage.—First segment yellow, the center above, including the greater portion of the space inclosed by the tubercles, black; second segment black, the anterior and posterior margins and the sides broadly yellow, that on the posterior margin being produced forward in the middle above; third segment yellow, marked with a pair of black spots in front and with a second pair behind the subdorsal tubercles; there is also a black spot in front of the upper of the two lateral pairs of tubercles, and another at the base of the posterior of the two lowest tubercles; fourth, fifth, and sixth segments black, marked with an irregular silvery-white stripe between the tubercles, the sutures of these segments yellow; seventh segment silvery-white, marked with a small black spot between the two upper tubercles and with a larger one behind the upper of the two lateral tubercles; eighth segment black, the greater portion of the space between the subdorsal tubercles silvery white, and there is also a spot of the same color at the base of the lowest tubercle; ninth segment black, the middle of the posterior margin, extending nearly as far as the upper of the two lateral tubercles, silvery white; tenth segment black, the posterior margin silvery white, which color crosses the segment obliquely between the subdorsal and the upper of the two lateral tubercles; eleventh segment like the tenth, except that there is a silvery-white spot at the base of the lower tubercle; twelfth segment wholly black; there is also a silvery white medio-dorsal line extending from the

second to the eight segment; venter yellow, the abdominal segments marked with dusky black; tubercles arranged as in the preceding stage, black, all of those on the first, second, seventh, eighth, ninth, and tenth segments yellow, as are also those on the third, with the exception of the posterior of the lowest two; the lowest tubercle on each side of the sixth segment is also yellow; the subdorsal tubercles near the posterior margin of the first segment are nearly as large as those on the sides of this segment; the anterior of the two lowest tubercles on the second segment is slightly longer than either of the three arranged in the form of a triangle above it; the anterior of the two lowest tubercles on the third segment is not half as long as either of the two above it; except on the first segment, none of the bristles are as long as the tubercles which bear them; head black, marked in the middle with a yellow spot. Length, 8mm.

Duration of this stage, eleven days.

Pupa.—Yellow, marked with a medio-dorsal row of oval black spots, one to each segment, and on each side of these is a row of larger black spots, one to each segment, except the first, those on the second segment sometimes connected along the front end of this segment with the median spot; wing-cases entirely, or at least their upper edges, black; entire surface thinly covered with a yellowish white, appressed, scaly pubescent; first and second segments bearing several short, erect bristles; remaining segments each bearing a large cluster of bristles in the subdorsal and also in the stigmatal region; length, 7mm.

Duration of this stage, eleven days.

In pupating the old larval skin is rent along the back from the head to the front end of the eighth segment.

The time passed by this ladybird in its preparatory stages from the depositing of the egg to the issuing of the adult insect is seen to be about sixty-four days, divided as follows: Egg, eighteen days; larva, thirty-five days (first stage, six days; second stage, seven days; third stage, eleven days, and fourth stage, eleven days); pupa, eleven days. These periods are for the months of August and September, the insects having been bred in breeding cages kept in the window of my office, where they received the benefit of the afternoon sun. It is probable that in the open air they would have passed through their various changes in a somewhat shorter period of time than that indicated above.

On the 14th of May of the present year I placed in one of my breeding cages, 10 of these ladybirds received that day from Sydney, Australia, and kept them well supplied with specimens of *Aspidiotus aurantii*, *Lecanium oleæ*, and various kinds of Aphides, but more than six weeks elapsed before any eggs were deposited. At certain intervals after this I removed the larvæ from this cage, and placed them on an orange tree thickly infested with *Aspidiotus aurantii* and *Lecanium oleæ;* on the 16th of August I thus removed about 100 of them, on the 5th of September 13 more, and on the 28th of September I placed the entire contents of this cage on the same orange tree. At this latter date several of the beetles originally received from Australia were still alive, which would indicate that they are comparatively long lived, since I had them in my possession for a period of over four months, and they may have been several weeks old at the time of their capture in Australia.

ORCUS CHALYBEUS.—*Egg.*—Elongate-oval or elongate-ellipsoidal, from somewhat over twice to nearly three times as long as broad, surface polished, the upper end scabrous and on one side of the middle bearing a white, flattened, branched process, having somewhat the appearance of an antler of a Moose-deer; color of egg, light lemon yellow; length, 1¼mm. Placed on one end in clusters of from 4 to 10 eggs each.

Time from deposition to hatching, eight days.

Larva.—First stage.—Body yellow, the tubercles dusty; first segment surrounded in front and on the sides by a row of ten long tubercles, and with a transverse pair of much smaller tubercles on the dorsum near the posterior end of this segment, each of these smaller tubercles being as broad as long; second segment bearing a transverse pair of long tubercles, each side beside a dorsal transverse pair of much smaller tubercles, and a single small tubercle in front of each of the lowest tubercles on this segment; each of these small tubercles is as broad as long; segments three to eight, each bears a transverse row of six long tubercles; segments nine and ten each bears a transverse row of four long tubercles; eleventh segment bearing a single transverse pair of long tubercles; twelfth segment destitute of tubercles; each of the small tubercles above mentioned bears a single long bristle at its apex; each of the long tubercles is truncated at its apex, where it bears a stout bristle which is usually longer than the tubercle itself; in addition to this, the second tubercle on each side of the middle of the dorsum on the second and third segments bears a second long, stout bristle on its outer side a short distance below the apex; each of the long tubercles also bears one or two short lateral bristles; the surface of the body is thinly covered with minute tubercles, each giving rise to a very short yellowish hair; head light yellow, thinly covered with slender bristles and bearing three black ocelli each side in the form of a triangle.

Duration of this stage, six days.

Second stage—Same as in the first stage with the following exceptions: Each of the small tubercles in the transverse subdorsal pair near the posterior end of the first segment, as well as those in the subdorsal pair on the second segment and the foremost one of the two lowest on each side of this segment, is nearly three times as long as broad; each of these smaller tubercles bears a single apical bristle which is slightly longer than the tubercle itself, and each of the remaining one bears a pair of apical besides several lateral bristles of various lengths, but none of them are as long as the tubercle itself.

Duration of this stage, six days.

Third stage.—Same as in the second stage, with these exceptions: Dorsum of segments two to nine black, most extended on the second and third segments; the tubercles in the dorsal pair near the posterior end of the first segment and also those on the second segment are nearly as long as the adjacent ones, being somewhat more than four times as long as broad, but the anterior of the two lowest tubercles on each side of the second segment is still much shorter than the others, and is scarcely over two-thirds as long as the posterior one; each of these tubercles bears several short lateral bristles.

Duration of this stage, seven days.

Fourth stage.—The black of the dorsum is extended so as to include four rows of tubercles, and on the second and third segments it is divided by a medio-dorsal yellowish line. There is also a yellowish line on segments four to nine between the first and second rows of tubercles each side. The black coloring on the outside of these lines is not so intense as it is within them. The anterior of the two lowest spines on the second segment is five-sixths as long as the posterior one. Otherwise as in the preceding stage. Length, when fully grown, 5mm.

Duration of this stage, fourteen days.

Pupa.—Light citron yellow, head almost surrounded with blackish, first three segments each marked with a pair of oblique black dorsal spots, those on the second segment the largest; fourth segment marked with a pair of small black dorsal dots

which are scarcely apparent; segments five to eight each marked with a pair of black dorsal spots, those on the sixth and seventh segments larger than the others; wing-cases bordered above with black; surface thinly covered with a light yellow pubescence; length, 5mm.

Duration of this stage, fourteen days.

From these data it will be seen that this species passes through its various stages in a somewhat shorter time than is the case with *Orcus australasiæ*. In all of its stages it is much more delicate than the last-named species, and the beetles appear to be much shorter lived. On the 14th of May I placed twenty adults of *Orcus chalybeus* in one of my breeding cages and kept them well supplied with specimens of *Aspidiotus aurantii* and *Lecanium oleæ*, but no eggs were laid until about two months later, or on the 25th of July; and the last beetle in this cage died on the 2d of August. Specimens of *Orcus australasiæ*, obtained at the same time as these and treated in the same manner, were still living nearly two months after the last *chalybeus* had died.

On the 10th of August a larva of *chalybeus*, only four days old, was attacked by a whitish, feathery fungus which spread out on all sides of its body, giving the latter the appearance of resting upon a miniature mat of feathers. I submitted this specimen to Dr. Galloway, the mycologist of this Department, by whom it was referred to Mr. J. B. Ellis, a well-known authority upon fungi, who reported that this fungus was either the *Microcera coccophila*, or else a species of Isaria, probably the latter. The Microcera here alluded to is known to attack various kinds of scale-insects in Australia, and it would be interesting to learn if the spores of this fungus were brought over with the ladybirds recently imported from that country; but a second letter to Dr. Galloway upon this subject elicited the fact that the specimen in question had been mislaid and could not be found.

NOVIUS KOEBELEI.—*Egg.*—Elongate-ovate, two and a half times as broad, the surface very scabrous; color, deep orange-red; length, 0.75mm. Attached lengthwise to the body of an Icerya, or thrust into the egg-sac of the latter.

Time from disposition to hatching, six days.

Larva.—First stage.—Body, including the head and legs, blood-red, the first three segments each marked with a pair of subdorsal black spots, those on the first segment the largest; first segment bearing four long bristles, two on each side, besides two shorter ones near the front end; second segment bearing a transverse pair of bristles each side, of which the upper bristle is the shorter; third segment like the second; segments four to nine, each bearing a single long stigmatal bristle each side, which springs from a small black tubercle; segments ten and eleven on each side bearing a subdorsal and a stigmatal bristle; twelfth segment destitute of bristles; the long bristles described above are slightly longer than the transverse diameter of the body, and curved upward; there are also several much shorter curved bristles thinly scattered over the body, and they likewise occur on the head and legs; on the under side of each femur are two long bristles; each tarsus bears four rather long, knobbed bristles, resembling the digitules on the tarsi of certain kinds of Coccids. Towards the end of this stage the body becomes thinly covered over with a very short, white, woolly substance.

Duration of this stage, five days.

Second stage.—Same as the first, with these exceptions: First segment bearing twelve long bristles, of which four are in a row along each side of this segment, one is located slightly above the second bristle in each of these rows counting from behind, besides a subdorsal bristle each side, situated near the middle of this segment; segments three to seven each bear a transverse pair of bristles each side; the longest bristles scarcely exceed the transverse diameter of the body.

Duration of this stage, three days.

Third stage.—Body, blood-red, the subdorsal region being the darkest, but there are no definite black markings; first segment bearing fourteen bristles, six of which are in a row on each side of the segment, and one is situated above the second bristle in each of these rows, counting from behind; segments two and three each bearing a stigmatal cluster of four bristles each side and with a single bristle in front of each of these clusters; segments four to nine each bearing a stigmatal cluster of four bristles each side; segment ten bears a subdorsal bristle besides the stigmatal cluster of four bristles each side; segment eleven bears a subdorsal bristle and a stigmatal cluster of three bristles each side; segment twelve bears a transverse row of four rather short bristles; each of the clusters of bristles above described issues from a large elongated tubercle the apex of which is rounded and blackish; the bristles in these clusters are arranged one in front, another behind, and with a transverse pair between them, but on the eleventh segment the anterior bristle is wanting; these bristles are of unequal lengths, the transverse pair being longer than the others, these but slightly exceeding one-half of the transverse diameter of the body; head slightly darker than the body and marked with a black spot on each side; legs red, the tarsi slightly blackish; the surface of the body is thinly covered with a very short, white, crinkled, woolly substance which does not entirely conceal the ground color.

Duration of this stage, three days.

Fourth stage.—Same as the third stage, with these exceptions: Body marked each side by a subdorsal black stripe which passes between two rows of low, transversely oval warts which are blackish at their apices, two warts to each segment, except on the second and third segments, where only the lower wart is present, but neither the warts nor the black stripes extend upon the first segment; this segment bears eighteen bristles, of which seven are arranged in a row along each side of the segment, and one is situated above the first and second bristles in each of these rows, counting from behind; the eleventh segment bears a stigmatal cluster of four bristles each side; the remaining bristles are arranged as in the preceding stage.

Duration of this stage, ten days.

Pupa.—Orange-red, first segment marked with a medio-dorsal black spot, second and third segments each with a large transverse black spot; segments six, seven, and eight each with a transverse black spot on its anterior end, that on the sixth sometimes divided medially into two spots; surface thinly covered with a short, light yellow, mostly recumbent pubescence, which converges towards the middle of the dorsum, forming a small cluster near the center of each segment; length, 4^{mm}.

Duration of this stage, fourteen days.

About three days before pupation takes place, the full-grown larva attaches itself to some object by the posterior part of the body, and in pupating the old larval skin is rent from the head to the anterior end of the seventh segment, and is allowed to remain, partially enveloping the pupa. About ten days after pupation takes place the pupa-skin is rent, disclosing the included beetle, but the latter does not issue from the pupa-case until four days after this stage is reached.

This ladybird breeds as readily in confinement as does the *Vedalia cardinalis* and closely resembles the latter in all of its stages. The obser-

vations above recorded were made during the months of August and September, and the insects were kept in glass jars in a sunny window of my office. The eggs are darker and much rougher than those of the Icerya, which they otherwise closely resemble, and are usually thrust into the egg sac of the latter. The young larvæ prefer the eggs of the Icerya to the insects themselves as food, and shortly after issuing from the eggs they burrow into an egg sac and frequently remain in it until full grown. On several different occasions I have reared a Novius larva from the egg to the adult state upon the eggs in a single egg mass of the Icerya. They spend a somewhat longer time in their preparatory stages than the Vedalia does, this being especially noticeable in the pupa stage; and being much smaller insects they do not destroy the Iceryas as rapidly as the Vedalia does. The latter appears to prefer the Novius larvæ to the Iceryas for food, and whenever the larvæ of these two ladybirds inhabit the same plant the Novius larva falls a prey to its more powerful rival. I learn from Mr. John Scott, the Horticultural Commissioner of Los Angeles county, that he introduced a few Vedalia larvæ into a glass jar containing a colony of the Novius, and, although he kept them well supplied with Iceryas for food, still in a short time the Vedalias had completely annihilated the Novius larvæ.

LEIS CONFORMIS.—*Egg.*—Elongate-ovate, twice as long as broad, the outline quite regular, tapering gradually toward each end, the upper end convex, the lower one flattened at its attachment; surface highly polished, but under a highly magnifying power appearing somewhat scabrous, owing to minute, blisterlike, raised spots which are thinly scattered over its surface; color, light lemon-yellow; length, $1\frac{1}{2}^{mm}$.

The eggs are attached by one end to a leaf or other object and are deposited in clusters of from three to forty-one eggs each. Time from deposition to hatching, seven days.

Larva: First stage.—Body of the usual Coccinellid form, being widest in front and tapering quite rapidly posteriorly; olive-brown, varied with black, and bearing many black, somewhat conical tubercles, each tipped with a black style which at its apex is compressed laterally and is truncate or sometimes slightly emarginate; first segment somewhat flattened above and bearing a circle of twenty-six tubercles; of these, the anterior fourteen (seven on each side) are arranged in a single row, and the style at the apex of each is longer than the tubercle itself; next to these are four transverse pairs of tubercles, two pairs on each side of the segment, the two tubercles composing the second pair being united at their bases; following these are four tubercles two on each side, in which, as also in the tubercles, comprising the four pairs above mentioned, the style is shorter than the tubercle itself: besides this circle of tubercles, there is also a transverse pair near the center of this segment; second segment, on each side, bearing a subdorsal oblique pair of tubercles which are united at their bases, a suprastigmatal cluster of five tubercles, three of which are united at their bases, the other two being slightly above and on either side of them; below this cluster is a single tubercle in front of which is a stout bristle; third segment the same as the second except that the suprastigmatal cluster contains only four tubercles, the anterior of the two single ones being absent; fourth segment, on each side, bearing a subdorsal cluster of three tubercles united at their bases, a suprastigmatal pair of tubercles which are also united at their bases, and below them is a single tubercle; segments five to eleven are the same as the fourth;

each of the tubercles on segments two to eleven is longer than the style at its apex; twelfth segment on each side bearing two subdorsal and two small stigmatal, widely separated tubercles, each of which is shorter than the style at its apex; head polished black and bearing a few stout bristles; legs black and also bearing a few stout bristles.

Duration of this stage, three days.

Second stage.—Same as the first, except that the color of the body is black and the tubercles on the seventh segment are yellow; the styles of the tubercles are not compressed at their tips; the united bases of the tubercles which are arranged in pairs or in threes are longer than the tubercles proper and each bears a few slender lateral bristles; the posterior tubercle in each cluster of three is longer than either of the others in the same cluster.

Duration of this stage, three days.

Third stage.—Same as the second, except that sometimes, but not always, some or all of the tubercles on the fourth segment are yellow.

Duration of this stage, three days.

Fourth stage.—There is no appreciable difference between this and the preceding stage.

This is as far as I was able to carry these larvæ, a host of mites belonging to the species *Heteropus ventricosus* of Newport having invaded my breeding cages and in a very short time destroyed not only these larvæ, but also many others which I was rearing at the same time, the soft, recently transformed chrysalides and pupæ being attacked as well as the smaller larvæ of all descriptions. No specimens of the Leis were received by me after the above date, so I was unable to procure a fresh colony of larvæ and thus complete the life history.

On the 14th of May I placed in one of my breeding cages about a dozen adult specimens of *Leis conformis* and supplied them with orange twigs infested with an undetermined species of Aphis. Three days later some of the beetles were paired, and on the 19th of May I examined the twigs in this cage, but found no eggs; I then replenished it with fresh twigs infested with the Aphides, and in the afternoon of the same day this cage contained two clusters of eggs, containing seven and ten eggs, respectively. The beetles were very lively and fed greedily upon the Aphides. The females laid eggs readily in confinement, even when inclosed in a small-sized box. The larvæ were comparatively easy to rear and fed readily upon the Aphides, large numbers of which were destroyed in a day by a single larva.

UNDETERMINED COCCINELLID, (elytra yellow, marked with six black spots).—*Egg.*—Elongate-ellipsoidal, two and a half times as long as broad, light lemon-yellow, the upper end marked with a rather large white spot, surface highly polished, but under a high magnifying power appearing slightly scabrous, owing to minute blister-like spots, which are scattered over its surface; length, $1\frac{1}{4}^{mm}$.

Placed on end in clusters of about ten eggs each. Time from deposition to hatching, five days.

Larva: First stage.—Body of the usual Coccinellid form, olive-brown varied with black, sides of the fourth segment lighter, almost white; first segment bearing a circle of twenty-six elongated tubercles, besides a transverse pair near the center

of the dorsum; second segment, on each side, bearing a subdorsal cluster of three tubercles, a suprastigmatal cluster of five, below which is a pair of tubercles, and there is also a single tubercle situated between the subdorsal and suprastigmatal clusters; third segment on each side bearing a subdorsal and a suprastigmatal cluster of three tubercles, while between these two clusters, and also below the lowest one, is a pair of tubercles; fourth segment, on each side, bearing a subdorsal and a suprastigmatal cluster of three tubercles, and below the latter is a pair of tubercles, the anterior of which is smaller than the posterior one; segments five to eleven are the same as the fourth; all of the tubercles above described are black; twelfth segment, on each side, bearing a pair of subdorsal and a widely separated pair of stigmatal bristles; head polished black.

I was unable to carry these larvæ any further, owing to the invasion of the mites above referred to. Two of the beetles were destroyed by internal parasites, as already stated on a previous page of this report; the remaining beetles died without depositing eggs, and as no more specimens of this insect were received from Australia subsequently, I was unable to obtain any more eggs of this species and thus complete its life history.

The beetles were received at the same time as the *Leis conformis* above described, and were treated in the same manner as the latter. They were not as lively as these and did not deposit eggs so readily in confinement. Both the adults as well as the larvæ fed greedily upon the Aphides which I introduced into their breeding cages.

THALPOCHARES COCCIPHAGA.—*Egg.*—Turnip-shaped, being twice as broad as high, attached at one end, the upper end rather deeply concave and furnished with a small rounded tubercle in the center; surface covered with irregular raised lines which encircle the egg, besides others which extend vertically, these lines forming shallow cells of various shapes and sizes; diameter, nearly $\frac{1}{2}^{mm}$. Deposited singly.

Larva.—First stage.—Body whitish; head grayish-black; cervical shield dark gray; provided with six thoracic, four abdominal, and two anal legs, the abdominal legs located on the eighth and ninth segments; these as well as the anal prolegs are extremely short, but are encircled with minute hooks at their tips.

Full-grown larva.—Body very robust, dull white, usually with a tinge of yellow or pink; piliferous spots indistinct, pale brown; spiracles yellowish; head and cervical shield blackish-brown; no anal plate; legs as in the first stage; length, 8^{mm}.

Chrysalis.—Of the usual form, light yellowish-brown; destitute of transverse rows of teeth-like processes; posterior end rounded and bearing a transverse, slightly curved row of six rather short, recurved spines.

Shortly after issuing from the egg the larva spins around its body an oval case of light gray silk, which it drags around after it when crawling about in search of food. This consists of the younger specimens of *Lecanium oleæ*, and perhaps also the young of other kinds of Coccids. As the larva increases in size it enlarges its case by the addition of new material, and it frequently attaches to the outside of its case fragments of the scales, besides various other small objects, these being so small in size as to be scarcely noticeable except upon a close inspection. The case is closed at one end, while at the opposite end is a somewhat square opening, out of which the larva protrudes its head and the fore part of the body when feeding or when moving about upon the tree. Each of the four sides of this opening is furnished with a rounded silken

lobe, or prolongation of the case, and these lobes converge toward the center of the opening, thus closing the latter when the larva retreats into its case. After each meal the larva fastens its case to the bark by a few silken threads, then retreats into its case and remains hidden from view until the pangs of hunger again force it to come out in search of food. The chrysalis stage is passed within the silken case, and frequently ten or a dozen of the cases are fastened together in a mass by their occupants a short time before the latter assume the chrysalis form.

It is quite impossible to extract one of these larvæ from its silken case without fatally injuring the larva, so firmly does it retain its hold upon the inside of the case by means of the small hooks with which the prolegs are provided, and nothing short of cutting open the case will accomplish the removal of the larva. When removed from its case and placed upon a flat surface the larva is able to move about, but only very slowly, and in walking the posterior end of the body is elevated, no use being made of the last pair of prolegs. Whenever two of the larvæ thus removed from their cases meet each other a fight is almost certain to occur, each larva seeking to grasp with its mandibles the mouth parts of the other, and, if successful, it will frequently shake from side to side the head and fore part of the body of its opponent, somewhat as a terrier shakes a rat. In these encounters the softer parts of the body are never attacked, and the encounters are apparently in the nature of sport. The moths, as might be expected, are nocturnal in their habits, remaining perfectly quiet during the daytime and coming forth rather early in the evening.

My notes on this species are necessarily imperfect, as but few of the larvæ were obtained from eggs laid in confinement, and in order to work up their complete life history it would be necessary to frequently remove the larvæ from their cases, and this I was unwilling to do until the species becomes firmly established in this State.

At the present writing two of the most important of the imported species, the *Orcus australasiæ* and *Orcus chalybeus*, are breeding in two localities in this city, as well as in an olive grove in Santa Barbara County, and the former species is also breeding in Alameda County. While they do not increase with sufficient rapidity to give us the assurance that they will be able to practically free all of the trees in this State of the different kinds of scale insects that infest them, still they will undoubtedly prove valuable allies in keeping these scale insects in check.

Novius kœbelei is also firmly established here. I have it breeding in my office at the present writing, and have sent a few colonies to different localities in the State. The horticultural commissioner of this county, Mr. John Scott, also has colonies of this insect breeding in his office, and has sent out colonies in place of the *Vedalia cardinalis*. While this last-named insect has effectually kept in check the destruc-

tive Fluted or Cottony-cushion Scale (*Icerya purchasi*), still of course there is abundant room for this second species to aid in this commendable work. Being much smaller than the Vedalia and not passing through its changes any more rapidly, it is very doubtful whether the Novius could have accomplished the same work in the same time that the Vedalia did in California.

It is very probable that four other kinds of beneficial insects, the *Leis conformis*, *Alesia fromata*, the reddish-yellow ladybird with six elytral black spots, and the small black one with two large elytral red spots, are also established here, but these were received in such small numbers that some little time must elapse before they will have multiplied sufficiently to be met with except after a long and careful search for them. It is also possible that the Cryptolæmus and two or three species of Scymnids, as well as the Thalpochares, may yet be found to have gained a foothold here, but this can be determined only after the lapse of several months, or perhaps even longer than this. I have already alluded to the fact that the *Scymnus lophanthæ* was also among the specimens introduced, but this can hardly be considered an introduction in the same light as the other species, since it was already established here before these later specimens were received.

I have not observed that either of the two species of fungi received from Australia, the one attacking *Lecanium oleæ*, the other on *Aspidiotus aurantii*, has spread to the healthy scale insects, but of course it is possible that the spores of these fungi may remain dormant until the wet season sets in.

THE WALNUT SPAN-WORM.

The English Walnut is quite extensively grown in certain localities in this State, and, in proportion to the amount of care bestowed upon it, yields a larger revenue than almost any other tree grown upon this coast. It is remarkably free from the attacks of insects, those heretofore known to attack it never occurring in sufficient numbers to cause any widespread destruction of the trees or nuts. Two years ago, however, a span-worm appeared in such large numbers in a certain locality that many trees were almost completely defoliated by it.

The first intimation I received in regard to the appearance of this new pest was a letter from Hon. Ellwood Cooper, of Santa Barbara, under date of April 29, 1890, and which reads as follows:

I send you by this mail a box of worms. Please write me by return mail what they are, whether from a moth, miller, butterfly, or beetle. What kind of eggs, and the time required for them to hatch? When do the worms go into the pupa state, and where? Nothing of this kind has ever been seen on the ranch before. My foreman said he saw the very small worms about ten days ago. I had never seen anything on the walnut trees, and hence did not at once go to look after them. A few days later I made an examination, but could find no eggs, yet very minute worms. I sent the foreman, but none could be found. The eggs must have been laid on the twigs, because the leaves have only been out about fourteen days. About one week

ago there were but few signs, now the whole thing is being eaten up. I never saw anything so ravenous. Please write me at once what to do and what it is. I fear the crop is gone.—ELLWOOD COOPER.

Thinking the matter of sufficient importance to require investigating, I paid a visit to Mr. Cooper soon after the middle of May. Prior to this, however, the trees had been sprayed with Paris green and water at the rate of 1 pound of Paris green to 130 gallons of water, and now it was no easy matter to find any living, healthy worms. The trees attacked were very large ones, being about 30 feet high, and the branches extending a distance of nearly 20 feet, making for the tops of the trees a diameter approximating 40 feet. The span-worms appeared upon nearly every tree in a grove containing 20 acres, but they were most abundant near the center of the grove, where they had almost completely defoliated the trees. They also appeared upon the walnut trees in an adjacent grove, but not in such large numbers as in the one above mentioned. Mr. Cooper informed me that he has lived on this ranch continuously for nineteen years, but never before had these or any other kind of span-worms appeared upon his trees in sufficient numbers to attract attention, and he is unable to account for the present invasion.

The following year these span-worms were also present upon some of the trees, but were far less numerous than during the preceding year. The infested trees were again sprayed with Paris green and water at the rate of 1 pound to 180 gallons, and this effectually destroyed the span-worms. In the month of March of the present year, however, Mr. Cooper wrote me that the span-worms were again appearing in large numbers and requested me to come to his ranch and investigate them. Having received instructions from Dr. Riley to this effect, I again, on the 6th of April, visited Mr. Cooper, and found that, while the span-worms were quite abundant upon some of the trees, still they were in much smaller numbers than during the season of 1890. I also made a careful examination of the trees growing near the walnut trees; these consisted of Olive, Persimmon, Eucalyptus, Sycamore, Alder, Oak, Elder, Willow, and a few other kinds of trees, besides various kinds of shrubs and plants, but failed to find specimens of this span-worm upon any of them, with the single exception of the Oak (*Quercus agrifolia*). The new, spring growth was just starting out upon this tree, and I found several of these span-worms feeding upon the newly expanded oak leaves; a careful comparison of these oak-feeding specimens with those from the walnut trees failed to disclose the slightest difference, and when I tested them with walnut leaves they also fed readily upon them. Several trees of black walnuts are also growing on Mr. Cooper's ranch, but these were not yet in leaf at the time of my visit.

During a visit which I made, in the latter part of April, to portions of Alameda and Santa Clara counties I found specimens of this same

kind of span-worm on some apple and prune trees as well as on English walnuts in some of the orchards of the above-mentioned counties. Under date of April 27, 1892, Mr. Cooper writes me that he recently found this pest in three other groves of English walnut in Santa Barbara County, where it was very destructive to the leaves of these trees. Thus it appears that already this span-worm is quite widely distributed over the State, and unless active measures are adopted to suppress it there is every probability that it will in time very seriously interfere with the profitable growing of English walnuts upon this coast. Unfortunately, the moths have not yet issued, so it is impossible at the present writing to identify the species or to ascertain if it has proved destructive in other States than our own.

The eggs from which these span-worms hatch are flattened oval, as if compressed between the thumb and finger; the surface is quite scabrous, and bears numerous minute transverse ridges; at each end of the egg are numerous quite large, shallow punctures; the color is a dark greyish drab, with a strong brassy tinge; length, about $\frac{5}{6}$ mm.

These eggs are fastened to the small twigs of trees, in loose, irregular patches, each egg lying on one of its flattened sides; there is no regularity in their arrangement upon the bark of the twig. One piece of a twig an inch and a half long by a quarter of an inch in diameter contains upwards of two hundred of these eggs. The young span-worm issues through a nearly circular hole in the larger end of the egg, and the empty eggshell is of an iridescent, pearly white color.

The full-grown span-worm closely resembles the larva of the Eastern *Angerona crocataria* as figured on Pl. VIII, Fig. 6, of Packard's "Guide to the Study of Insects," but the piliferous spots are larger, giving to the body a much rougher appearance, and when viewed from the side there is seen to be a large prominence on the dorsum of the fourth and sixth segments as well as on the fifth and eleventh. I give herewith a detailed description of this span-worm, in order that it may be recognized in the future:

Body of nearly an equal thickness throughout its length, the head and first thoracic segment slightly wider than the rest of the body; head as seen from front a trifle wider than high, the lobes rounded and destitute of a tubercle or other process; color of head dark brown, variegated with yellowish; body light pinkish gray varied with darker gray or purplish, or sometimes with black and yellow, never marked with distinct lines; piliferous spots tuberculiform, black, or dark brown, and back of each of the spiracles situated on the fifth and sixth segments is a large, conical, fleshy prominence surmounted by a piliferous spot, and on the dorsum of each of the segments four, five, six, and eleven, is a pair of similar but smaller prominences; in front of the pair of prominences on the dorsum of the eleventh segment is a pair of spots which are of a clearer yellow or gray than the ground color, each spot usually bordered each side by a short black line; spiracles orange-yellow, ringed with black and usually situated on a yellow spot; venter concolorous with the upper side, marked in the middle with a faint whitish stripe, and with a less distinct one near each outer edge; ten legs; length, 20mm.

These span-worms reach their full growth in May and then enter the earth to a depth of from two to four inches; here each one forms a smooth cell, but does not spin a cocoon. The chrysalis state is assumed a few days after the cell is completed, but the moth does not issue until the following winter or early spring. The chrysalis is of the usual form, of a dark reddish brown color, and the posterior extremity bears two diverging spines; the tips of the wing-cases almost reach the posterior end of the fifth abdominal segment; length, 14^{mm}.

Perhaps the most important enemies of these span-worms are certain kinds of insectivorous birds, particularly the black birds, which I repeatedly observed in the infested trees, and Mr. Cooper informs me that he has seen one of these birds carrying four of the span-worms in its beak. Of internal parasites, only one species is at present known to me to attack these span-worms; this is a small black, four-winged fly belonging to the genus Apanteles. The sides of its abdomen are largely yellow, the front and middle legs, including their coxæ, are also yellow, while the hind legs, with the exception of the tips of the femora and tibiæ, and the whole of the tarsi, are of the same color. I found several of the white cocoons of this parasite attached to the trunks of the infested trees on the 21st of May, and near each was the shrunken remains of one of the span-worms in which the parasite had lived. One of the parasitic flies issued one week later. It is probable that a Tachina-fly of some kind also attacks these span-worms; on the day above mentioned I found one of them to whose body was attached a white egg, evidently of one of these flies, but as no parasite issued from this span-worm I am unable to settle this point at the present time.

Mr. Cooper informs me that he sprayed some of the infested trees with Buhach and water at the rate of 1 pound to 50 gallons, but this did not destroy the span-worms. He also tried the kerosene emulsion, such as he uses for the destruction of the Black Scale (*Lecanium oleæ*) on olive trees, but this was not effectual. Paris green was also used in varying strengths, from 1 pound in 50 gallons to 1 pound in 200 gallons of water, and this latter strength he found effectually destroyed the span-worms without injuring the trees. With each 100 gallons of this mixture he used 20 pounds of a soap made principally of mutton tallow and caustic soda; this caused the solution to spread more readily over the leaves, and also had a tendency to cause the poison to adhere more firmly. The soap was first dissolved in hot water, after which the Paris green was added, then the balance of the water, and the solution was kept constantly stirred while being applied to the trees. Mr. Cooper informs me that five men—one to drive the team, one to stir the solution in the spraying tank, another to pump, and two to handle the spraying nozzles—sprayed on an average 27 of his largest walnut trees in a day; this is equivalent to one acre of trees per day.

THE CODLING MOTH.

(*Carpocapsa pomonella* Linn.)

It is not my purpose to give a complete account of this insect at the present time; its habits and life history are pretty well known to those of our fruit growers who suffer by reason of the inroads it makes in their deciduous fruit crops. A very full account of this pest, written by Mr. L. O. Howard, will be found in the Annual Report of the U. S. Department of Agriculture for the year 1887 (pp. 88–115). I will therefore simply record a few additional notes which have come under my observation during the last eight or nine years.

In the above-mentioned account it is stated that in the northern part of this country the Codling Moth is two-brooded, while in the south it is three-brooded. My notes indicate that in California, as might be expected, it is also three-brooded, the moths from the hibernating worms issuing in the latter part of March and during the first half of April, those of the next brood appearing in June and during the first half of July, while the third brood of moths appear in August and the early part of September.

Of the two kinds of internal parasites reported as preying upon the larvæ and pupæ of the Codling Moth in this country, the *Pimpla annulipes* is not represented in my collection from California. The second species, *Macrocentrus delicatus*, not heretofore known to occur upon this coast, I have never bred from the larvæ of the Codling moth; but my notes indicate that on the 3d of September, 1891, I bred three specimens of this parasite from larvæ of a Tortricid, *Pædisca strenuana* Walker, which lives in the dry stems of a wild sunflower, *Helianthus annuus*. I notice that in volume III of INSECT LIFE (p. 59), the editors record having bred this parasite from another Tortricid, the *Cacœcia fervidana*, as well as from one of the Dagger-moths, *Acronycta oblinita*, making in all four different insects upon which it is known to prey.

In the above-mentioned account it is stated that the Dermestid beetles, *Trogoderma tarsale* and *Perimegatoma variegatum*, are reported as preying upon the pupæ of the Codling Moth in California. My observations on the larvæ of these two beetles lead to the belief that the Trogoderma larva feeds upon dead insects, but will not attack the living ones; on the other hand, while the Perimegatoma larva doubtless prefers dead insects upon which to feed, yet it will also feed upon the smaller living pupæ, or chrysalides, of moths; and perhaps also those of other insects.

This latter larva bears quite a close resemblance to the one figured at 396, on page 448, of Packard's "Guide to the Study of Insects." It is of a dark-brown color, with the sutures of the segments whitish; the body is quite hard, somewhat flattened, of nearly an equal width throughout, except that the last fourth tapers slightly posteriorly, and the body is a trifle widest at the fourth segment; there are appa-

rently only eleven segments, the first of which is the longest, and is nearly as long as wide; the last segment is rounded behind, and is destitute of a projection of any kind; the body is thinly clothed, with rather long yellowish and dark-brown hairs, and in the older individuals each of the last three or four segments bears a transverse pair of short, brush-like tufts of black hair, which are wanting in the younger individuals; the head is nearly as wide as the first segment of the body, is of a reddish brown color, and is thinly covered with rather long reddish hairs. This larva attains a length of about 6^{mm}, and the pupa is formed within the old larval skin, the latter simply splitting open along the back. The larvæ are found during the greater portion of the year, and are quite frequently met with among the dead leaves and other débris lying in the crotches of orange trees. I have bred the beetles in June and also in December.

On the 17th of July, 1890, I found a larva of this kind engaged in feeding upon a dead and dry moth. I also inclosed three of them in a box containing a dead and dry chrysalis of the moth *Tæniocampa rufula*, and in a few days they had devoured it. I then placed in their box a living chrysalis of this moth, but they did not harm it, and in due time it was changed to a moth. A fresh, living chrysalis of a Tineid moth which I placed in their box, however, did not fare so well; I saw one of the larvæ feeding upon it, and it was finally entirely consumed. I also placed in their box a living chrysalis of a Codling Moth still in its cocoon, and they finally gnawed a hole through the cocoon, entered, and devoured the chrysalis.

The fact above recorded, that one of these larvæ was found feeding upon a dead, dry moth, and the further fact that the larvæ devoured a dead dry chrysalis of a moth, but would not attack the living chrysalis of the same kind of moth, is sufficient evidence to prove that these larvæ prefer dead and dry insects to living ones. Still, the other cases here recorded indicate that under certain conditions they also attack the healthy living chrysalides.

The larva of the Trogoderma quite closely resembles that of the Perimegatoma above described, but is a much more robust form; the body is widest at the last third of its length, and is of a lighter, more yellowish color; the short brushes of hairs on the posterior portion of the body of the older individuals are also yellow instead of black. I have repeatedly found these larvæ within the empty cocoons of the Codling Moth, but there was nothing to indicate that they had entered the cocoons prior to the escape of the moths, and it is probable that they fed only upon the empty shell of the chrysalis and the cast-off skin of the larva. I placed a dead and dry Horse-fly in a box containing several of these larvæ, and they soon attacked it and in a comparatively short time reduced it to a powder. I then placed in their box a living larva and two living chrysalides of a Tineid moth, but they had not attacked either of them after a lapse of six weeks. This would seem to indicate

that these larvæ feed only upon dead insects, and that they never attack those still alive.

For the destruction of the Codling Moth our growers of deciduous fruits depend almost altogether upon spraying the young fruit with Paris green and water. The proportions vary from 1 pound of the Paris green in 160 gallons of water to 1 pound in 200 gallons. My own observations and experiments indicate that the former strength is liable to injure the leaves somewhat, so it will be advisable to use it not stronger than at the rate of 1 pound to 200 gallons of water.

On the 12th of May, 1890, I had twenty-two pear trees sprayed with Paris green and water at the rate of 1 pound in 160 gallons, and to this was added 4 gallons of the resin wash, composed of: resin, 20 pounds; caustic soda, 6 pounds; fish oil, 3 pints, and water sufficient to make 100 gallons. This was added for the purpose of causing the solution to spread more readily over the trees and fruit. These pear trees were kindly placed at my disposal by Mr. C. H. Richardson, of Pasadena. They averaged about 10 feet in height, and the tops measured about 4 feet in diameter. Twenty-eight gallons of this solution were used on these twenty-two trees. I examined them at intervals throughout the summer; the fruit had not been in the least injured by the solution, but a very few of the leaves had small brown spots burned in them, not sufficient, however, to produce any material injury. When ripe, fully five-sixths of the pears on these trees were free from the attacks of the larvæ of the Codling Moth, whereas on adjacent trees not treated nearly all of the fruit had been attacked by these larvæ.

Throughout the entire summer season these sprayed trees remained free from the attacks of the Pear-slug (*Eriocampa cerasi* Peck), although I found leaves on some of these trees in which the eggs of this insect had been deposited; and upon adjacent pear, apple, and quince trees that had not been sprayed these slugs were quite numerous. It would well repay our growers to spray their trees with the above-mentioned solution as a protection against the attacks of these slugs and other leaf-eating insects.

It is the custom of some of the growers in the northern part of the State to first dissolve the Paris green in ammonia before adding it to the water, but it is very doubtful that this is any improvement. Ammonia is known to be very injurious to vegetation whenever brought in contact with it. I am informed by Dr. H. W. Wiley, the chemist of this Department, that Paris green, which ordinarily consists of a mixture composed of one molecule of the acetate of copper and three molecules of the arsenite of copper, is changed to an entirely different chemical compound when treated with ammonia, this compound then consisting of the acetate and the arsenite of ammonia combined with an ammoniate of copper—a mixture much more soluble in water than Paris green is. It is evident that the more insoluble the Paris green is rendered the less liability there will be of its injuring the foliage of

trees sprayed with it, and there will be less danger of its being washed off of the trees by the rains. Instead, therefore, of seeking to render it more soluble, the opposite course should be pursued, and, if possible, the Paris green should be treated in such a manner as to render it wholly insoluble in water. To accomplish this result it is only necessary to mix a pound of freshly slaked lime with each pound of the Paris green, add a gallon or two of water, and let stand over night. Treated in this way, the portion of the Paris green that is soluble in water, and that produces the injury to the trees sprayed with it, unites with the lime to form a compound wholly insoluble in water; by this simple and inexpensive treatment the Paris green is rendered harmless to the tree, while at the same time its poisonous nature is not lessened to any appreciable extent. This process was first used by Prof. C. P. Gillette, now entomologist of the Colorado Experiment Station, and his observations have been confirmed by a number of other experimenters.

The great benefits resulting from treating fruit trees with Paris green for the destruction of the Codling Moth are well understood by the majority of our growers of deciduous fruits, a few of whom have learned this by bitter experience. At a recent meeting of the horticultural commissioners of southern California, Mr. John Scott, the commissioner for Los Angeles County, stated that early in the present season he instructed his inspector in a certain locality to serve a notice on all of the fruit growers in his district to spray their pear and apple trees with Paris green and water for the destruction of the Codling Moth. The majority of the growers complied with the request, but one of them, for some reason, asked to be allowed to defer the spraying for a short time, and his request was granted. The spraying, however, was deferred longer than was originally intended, and it was now considered too late in the season to obtain good results, so his trees were not sprayed. Long before his pears were ripe this grower made a contract with the manager of one of the canneries in this city whereby he was to deliver his crop of pears to the cannery, for which he was to receive the sum of $2,000. When, however, he delivered his first load of pears, so badly were they infested with the larvæ of the Codling Moth that the manager of the cannery refused to accept them. The grower then offered them at three-quarters of the original price, but his offer was refused; he next offered them for one-half of the price originally agreed upon, but the manager informed him that he would not accept the pears even if they were given to him free of all expense. By the outlay of a very small sum of money necessary for spraying the trees all of this loss to the grower might have been averted.

REPORT UPON INSECT INJURIES IN NEBRASKA DURING THE SUMMER OF 1892.

By LAWRENCE BRUNER, *Special Agent.*

LETTER OF SUBMITTAL.

LINCOLN, NEBR., Nov. 12, 1892.

SIR: As special field agent for Nebraska, I submit herewith a report upon insect injuries in this State during the summer of 1892. The report touches upon the outlook for destructive locusts, but is mainly devoted to a consideration of certain sugar-beet insects, with a brief notice of the miscellaneous injurious insects of the season.

Very respectfully yours,

LAWRENCE BRUNER.

C. V. RILEY,
U. S. Entomologist.

DESTRUCTIVE LOCUSTS.

On account of the great amount of injury done by destructive locusts during the past few years and because of their threatened increase again early the present season in many localities over the country at large, a careful watch has been maintained during the season that has just passed for reported injury to crops by these much-dreaded insects. It is with pleasure, therefore, that I am enabled to state that comparatively little damage has been done by them the country over. True, in a few localities, there was some local injury; but, when we take into consideration the fact that last year a number of different species were unusually numerous in various portions of the country, west, north, south, and east, it is certainly encouraging, to say the least, that so little injury has resulted the present year.

Here in Nebraska several species hatched in rather large numbers and began to do some injury to gardens; but during the summer these became more or less infested with parasites of different kinds. These parasites thinned their ranks materially. In a number of localities the fungous disease known as *Empusa grylli* killed off myriads of the

remaining individuals, while at the same time others became literally covered with the Locust Mite (*Trombidium locustarum*). In fact, so extensively were these insects beset with afflictions of one or another kind that but few eggs were deposited. Even where they were, the large number of the egg parasites present will likely insure comparative immunity from locust attack next year.

From the northward we have heard but little of the pest that at one time last year appeared to be becoming so formidable. In central Idaho and portions of Utah and Nevada, where several species did considerable damage to both crops and grasses on the range, comparatively little injury has been reported, while from Colorado, western Kansas, and southwestward, the pest seems to have dwindled to nearly the normal condition for the region. Even in portions of Indiana, Ohio, and other sections of the East, where last year these insects did some injury, the conditions have somewhat improved.

CAUSES FOR THIS DECREASE IN THEIR NUMBERS.

It is not at all surprising that these insects have so suddenly become less numerous in the many localities where they were so recently threatening devastation. The large number of parasites and predaceous insects which attack them have had an opportunity to increase also. These latter, together with the Entomophthora, which has been unusually abundant and severe during the past few years, have combined in reducing the pest. Here in the city of Lincoln and environments this year the dead bodies of *Melanoplus differentialis* were to be seen by the thousands clinging to weeds, stems of grasses, and other vegetation, where they were overtaken by death from the effects of the disease. On some single weeds more than a dozen of the hoppers were frequently to be seen. The dead bodies of other species like the *femur-rubrum*, *bivittatus* and *atlanis* were also occasionally to be met with upon the same weeds. These latter were, however, much less common.

One feature observed in connection with the distribution of locusts of this region was the presence in many parts of middle and eastern Nebraska of such species as *Dissosteira longipennis* and *Melanoplus spretus*, which must have come from abroad. Here at Lincoln both of these species were of quite common occurrence. On the university campus a female of the former was taken *in coitu* with a male of *Dissosteira carolina*. Other specimens of the same species were taken at Norfolk, Grand Island, West Point, and Columbus, and even in the vicinity of Hot Springs, S. Dak.

Such species as *Camnula pellucida* and the glaucous-legged form of *M. atlanis*, that have been mentioned on former occasions as gradually moving eastward and southward, were this year met with in rather large numbers in different parts of the Black Hills and even in the northwestern counties of Nebraska.

BEET INSECTS.

Possibly more attention was paid during the summer to sugar-beet enemies than to any other class of insect pests in the region watched by me. This was due to the interest which is centered in that particular crop at the present time and also because of my having already paid considerable attention to this subject. It is needless, therefore, for me to state that during the season several additional species have been found attacking that plant here in Nebraska. Among these a small Hemipteron (*Hadronema militaris* Uhl.), that has heretofore been frequently seen and taken on different species of Amarantus in the western part of the state and in Colorado, was very common, in fact quite numerous, upon a small patch of beets in Sioux county during the latter part of July. Like others of these Hemiptera it attacks the leaves and leaf stems by inserting its beak and sucking the sap. Usually, but not always, the points attacked show as stained or partially deadened spots. Two or three additional leaf-hoppers were also taken upon beets here and at Norfolk, West Point, Grand Island and other locaties where beet fields were visited. These, however, were not present in sufficient numbers to do any noticeable injury to the parts attacked. The names of these were not ascertained, but will be reported later if deemed advisable.

Blister-beetles of several species, though none that were new to the plant, were unusually common and troublesome at a number of localities within this State and parts of Kansas during the season. Here at Lincoln, as well as at other localities, the common black one, *Epicauta pennsylvanica*, was exceedingly annoying to the owners of patches of beets. This beetle always comes and goes in comparatively large numbers, and one never knows where it will settle in the field. Choosing certain plants the insects congregate upon them and either eat the leaves full of holes or completely strip off all the foliage before going to the adjoining plants. Or, possibly, as soon as one plant has been stripped, they will go to another part of the patch or else leave altogether. In Sioux county the small Spotted Blister-beetle, *Epicauta maculata*, appeared to be the most common of these insects, and was always met with in large numbers on upland wherever beets were growing or a clump of the *Chenopodium album* occurred. Others of the blister-beetles were taken in the beet fields during the season, but these were present in much smaller numbers, and did but little damage as compared with what was done by the two species named above. Hand picking was more successfully used in combating these insects than any other remedy tried. Poisons in the case of *Epicauta pennsylvanica* proved to be of little or no value, since the insects often left immediately after the application was made, and at all times before they had eaten sufficient of the poisoned leaves to have any visible effect upon them. In the case of the Spotted Blister-beetle, poison was not tried that I am aware of; but I believe it would be more effective

against it than against *pennsylvanica*, for the former is less easily disturbed when feeding, besides being more regular in its habits than the latter. Like that species it is exceedingly gregarious in its nature, and always occurs in immense numbers when found at all.

Some indications were found at West Point of the possible injury that can be inflicted upon the beet crop by White Grubs. Here on one small field it was found that fully 15 per cent of the beets had been killed or injured by some insect working under ground. An investigation soon showed the criminal to be the grubs of some one or more species of *Lachnosterna*. These grubs had eaten away the tap-root and all the fine fibrous roots at a distance varying from 6 to 8 or 9 inches below the surface, but averaging about 7 inches. A dry spell coming on the tops began wilting, and finally died, after which the roots rotted in the ground. In this case the ground had been idle a year or more. This would suggest to us the advisability of not using grass land for beets; but to plant in ground that has been thoroughly cultivated for two or more years prior to its use for beets.

The Beet Web-worm.—Preëminent among the insects that attacked the beet crop here in Nebraska during the season which is just coming to a close, were two or more species of web-worms belonging to the genus *Loxostege* as at present restricted. Of these the one known as *Loxostege sticticalis* has been the chief depredator. Its history as an injurious species can be given briefly, as follows: By investigations instituted here at the experiment station only after the injuryhad mostly occurred it was ascertained that last year it was noticed that beets growing in the vicinity of Grand Island, Norfolk, and some of the adjoining towns, which supplied the beets for the two factories in the state, were infested by a few of the worms. These, however, did not appear in sufficient numbers to cause alarm at the time, or even to suggest to the interested parties the advisability of learning something of their nature, life history, and possible remedies. This year the caterpillars again made their appearance in these same localities and also at the Government station located at Schuyler. Considerable injury was done at this last-named locality on the experimental plats of sugar beets by a brood of the worms that matured late in July. Whether or not this was the first brood that appeared during the season is not positively known; but that it was the first brood that did visible injury is quite evident. Had this been otherwise the notice of Mr. Maxwell would have been called to them earlier in the season. As soon as the insect was observed by him to threaten the beets in his charge, as I am informed, specimens were at once sent to you in Washington. He also told me that experiments were at once started with a view to controlling the pest. Just what was accomplished in that direction I was unable to learn at the time of my visit to Schuyler on the last of August when the next brood was at its worst, but I presume he has reported to the Department just what was accomplished in this direction.

We did not have the insect here at Lincoln in sufficient numbers to attract attention. Although several larvæ of the ordinary Garden Web-worm (*Loxostege similalis*) had been taken early in July, nothing was thought of the matter and no further considerations taken concerning them until after the destructive brood had done its work at Grand Island and Schuyler, and a report of its presence and injuries was seen in the state papers. A special inspection of our beet plats at this time resulted in the finding of a number of specimens of another web-worm that we had noticed on several former occasions working on Amarantus and Chenopodium, but not on the beet. Upon visiting the station at Schuyler it was found that this second web-worm was identical with the one which occurred there; and, as Dr. Maxwell assured me, the same as was then present at Grand Island and several others of the surrounding towns where beets were being grown. A couple days later the same insect was found to be quite plentiful at Norfolk, Platte Center, and Genoa, where many of the beet fields either had been stripped or were at the time being stripped of their leaves. At Norfolk the greater part of half a day was spent in company with Mr. Huxman, the agriculturist in charge of the fields which supply that factory. Here a careful examination of the grounds was made and some facts gathered in relation to the insect as it appeared in this locality at least. Several new insects were here added to the list of "beet insects" as heretofore recorded. Afterward Norfolk, Stanton, Wisner, Beemer, and West Point were visited. At each of these localities sugar beets had been planted for the Norfolk factory, and at each some signs of the insect in question were found, though in much smaller numbers than where beets had been grown the year before.

From observations made at these different localities, and from information gathered through conversations held with various persons who were interested in the culture of beets, the following facts were gathered: These web-worms are more numerous away from sheltered localities than near bordering groves; and on high grounds, as hill tops and slopes, than on low flat grounds; they are never plentiful on a piece of ground planted to beets for the first time unless it adjoins one that was in this crop the year before; they are more plentiful in the middle of large fields than in small ones, and those that were allowed to run to "pig weeds" the preceding year, than in those where these weeds were kept down. The insects are also apparently more numerous where the soil is sandy than where it is heavier; at least this latter appeared to be the case in the localities where I made my observations. It was also learned that these web-worms are very subject to the attack of a number of parasitic insects, as well as falling prey to several species of predaceous beetles, bugs, and wasps, while birds and toads seem to relish them. Chief among the parasites reared from the specimens secured at Schuyler, Norfolk, and Grand Island is a small yellowish Hymenopterous fly. Next in point of numbers is a species of flesh-fly.

This latter was observed to be rather common in the fields both at Schuyler and Norfolk, while it has been bred in fairly large numbers from Grand Island worms. In addition to these, several other parasites have thus far been bred from the web-worms contained in my breeding cages.

As to the life history of these web-worms we are posted only in a general way, and not specifically. Our observations on the present species, *Loxostege sticticalis*, have not extended over a period of more than three months, hence we can not positively assert how it carries itself throughout the year. That it varies somewhat in its transformations and developments at different periods of the year is quite evident from what little we have seen of it so far. But two weeks is required between the maturity of the late July caterpillars and the appearance of the moths for the next brood. These immediately mate and deposit their eggs for another brood. The worms must therefore transform to chrysalids immediately after entering the ground. Such is not the case with the caterpillers of the last brood. With these the chrysalis stage is not entered for some time—possibly not until very late in the fall or even during the following spring. When I visited the Grand Island fields, fully three weeks after the last worms had entered the ground, they were found still in the caterpillar stage. Even at the present writing most of those in my breeding cages are unchanged. In this respect the insect imitates the slugs of some of our saw-flies. Its burrow is made and lined with silk, and the inner cocoon constructed immediately on entering the ground, but the worm instead of at once changing to the pupa stage lies in a semi-torpid condition until the proper time arrives for the change to take place, whether the insect enters the ground during the summer brood or broods when transforming, was not learned; but, if its life history is similar to that of the common Garden Web-worm, *Loxostege similalis*, it does not, but merely spin among the débris on top of the ground. Some of the larvæ of the August brood transformed and issued during September and October. It is barely possible that there is another set of caterpillars produced by these stragglers during the fall if the weather permits; but, as indicated above, the majority of the August brood remain unchanged until sometime during the following spring.

At least three distinct forms of these web-worms were taken from beet fields in different parts of the State, and a fourth one was found upon *Chenopodium album* growing in waste places here at Lincoln. Possibly still others might have been recognized if a close observation had been kept for that purpose. The similar food habits among the species of a genus of insects will very likely give us several more of these web-worms to add to our already large list of beet insects.

The web-worm found feeding on the *Chenopodium album* here at Lincoln can be recognized by the following description which was drawn up at the time of capture, and before it spun up: Length, 20^{mm}; slender,

tapering gently towards both ends. Of a light transparent green, the head and cervical shield inclining to amber yellow, but with a greenish tinge. Four small, whitish piliferous spots upon dorsum of segments—the anterior pair somewhat nearest together. Very fine hairs arising from these piliferous spots, as well as from sides. Larva very active—jumping aside and squirming vigorously when touched, as in the larvæ of Garden and Beet Web-worms. Also spins a slight web when feeding, to which it retreats when at rest.

Mamestra sp.—While walking through the beet fields at Norfolk a number of specimens of a Noctuid larva, apparently a Mamestra, were taken, in company with the web-worms mentioned above. This larva is about the size and has something of the same general appearance of the dark form of *M. chenopodii*, but differs from that insect in habits and markings. It was apparently quite plentiful, as specimens were taken at several different points in the fields, and three of them were found on a single row within 6 feet of one another. None of them were reared, as my breeding jar was overturned and the caterpillars destroyed by some one who meddled with affairs not belonging to his duties.

Anthomyia sp.—In connection with beet insects it might be well here to refer to a Dipterous larva that was taken here in Lincoln mining the leaves of *Chenopodium album*. Whether or not this is one of the species of Anthomyia which Lintner found mining the leaves of beet in New York, I can not say; but, from what I have observed heretofore in connection with these weed-feeding insects, there is danger of all of the enemies of the Chenopodaceous plants attacking the beet. Hence, whether this is a recorded enemy of the beet or not, it is very liable to become such sometime in the future. In its mode of attack this larva is somewhat peculiar, entering the leaf and feeding upon the pulp it soon separates the cuticles, making the leaves appear blistered. The maggot, in case of the Chenopodium, requires the substance of several leaves before coming to maturity, hence is obliged to pass from one leaf to another. These maggots are from 7 to 8^{mm} in length and nearly 2^{mm} in their greatest diameter. When ready to transform they enter the ground and there undergo their change to the pupa. One of the imagos issued within ten days of the time of entering the ground. The others, of which there were five, are still in the ground.

Silpha opaca.—During my visit at Norfolk and while talking with Mr. Huxman relative to Beet Insects in general, he mentioned the fact of the injury done by *Silpha opaca* in Germany. He said that the larva of this beetle was by all odds the most troublesome insect pest with which beet growers in that country had to deal. Hand picking was the remedy usually resorted to. He also stated that he had seen several specimens of the insect during the past summer at West Point, this State, upon sugar beets, and that he had killed them. He said that he could not be mistaken about the insect, as he had seen too

many of them in Europe not to know them at sight. With this second reported presence of this insect in beet fields at this one locality it begins to appear that perhaps, after all, it is present in America.

CHINCH-BUG NOTES.

While this insect has not been general over the State, it has begun to increase in such numbers in some of the counties along our southern boundary as to cause an uneasy feeling among the farmers of the section in question. Several letters have been received from different individuals in the counties of Nuckolls, Franklin, and Fillmore, asking for aid in the suppressing of this insect, which, as their letters stated, was becoming quite numerous and was threatening the fall wheat. They all asked for diseased bugs with which "to innoculate the healthy ones" in their respective neighborhoods. These letters were received during the latter part of September. Heavy rains have fallen in the region since, and nothing further concerning the bugs has been heard.

MISCELLANEOUS INSECTS.

Aside from the damage to beets by web-worms, the most marked injury done by insect pests in Nebraska during the season which has just come to a close was due to the presence of several species of caterpillars and saw-fly larvæ. Some of these have been excessively numerous in portions of the State, where they did great injury to the trees attacked. Some of these were the tent caterpillars, Fall Web-worm, the Walnut Datana, Cecropia larva, Green-striped Maple-worm, Tussock Moth, the Ash-tree Sphinx, *Cœlodasys unicornis*, and a species of Lyda (?) that worked upon the wild and tame plums. The Pear-tree Saw-fly also made its appearance within the State and did some injury to trees growing near Norfolk, in Madison County.

In towns and cities the caterpillar pest appears to be greatly on the increase, and it is next to impossible to impress upon the authorities the necessity for taking decisive steps toward their destruction. The comparative absence of insectivorous birds and of predaceous and parasitic insects is the cause for their increase. These latter are kept down by the burning of rubbish and other refuse under which they hide and spend their winters.

REPORT ON INSECTS OF THE SEASON IN IOWA.

By HERBERT OSBORN.

LETTER OF SUBMITTAL.

AMES, IOWA, *November 5, 1892.*

DEAR SIR: I inclose herewith a report on some of the observations for the year 1892, and beg to acknowledge at this time the many favors received which have been a material assistance in the prosecution of the year's work.

Very respectfully yours,

HERBERT OSBORN.

Dr. C. V. Riley,
U. S. Entomologist, Washington, D. C.

Perhaps the most striking features of the insect conditions the present year have been the almost total absence of many of the common pests during the early part of the season, a consequent slight amount of damage from insect attack, and the rapid multiplication of insects during the later months of the year and some quite conspicuous injuries. One of the most striking instances of this is to be noted in the plant-lice which were exceptionally rare during the spring and summer, but in late summer and autumn multiplied prodigiously and caused serious injuries to many kinds of plants.

The season was unusually backward and the spring months marked by much rain and cold weather, which retarded insect life in general.

Such reports as were received during the early part of the season indicated little if any damage even from such common pests as cutworms, squash beetles, etc.

The species of "bill-bugs" (Sphenophorus), which have been scarcely noticed in the State heretofore, have become plentiful, and one species, *Sphenophorus parvulus*, quite threatening in its attacks upon corn. This indicates naturally a considerable damage to grasses and probably wheat and other cereals, which passes without notice. It is quite probable that this species will demand serious attention from Iowa farmers during the next few years. *Sphenophorous ochreus* has attracted some

attention, but no serious damage has resulted from its presence so far as I know, and I do not anticipate from it any serious difficulties for this State. Attention has been called to these in a paper read before the Association of Economic Entomologists at Rochester and published in INSECT LIFE (vol. V, p. 111), and no further notice of them need be given here. Several cases of insects affecting grain in storage have come to my notice, and especially in the case of mill owners there seems to be a decided interest in the subject and a desire to adopt remedies for the insect pests that infest their mills. It is needless to add that the recommendation of bisulphide of carbon has given very satisfactory results.

The Potato Stalk Weevil (*Trichobaris trinotata* Say) has been quite plentiful and destructive, causing a loss of a large percentage of the crop on the college farm and probably over a considerable part of the State, though from the nature of its attack it seems to escape the notice of most growers.

A quite notable outbreak which came directly under observation was that of the Diamond-back Moth (*Plutella cruciferarum*) upon Rape, Cabbage, Cauliflower, and related plants. This insect has seldom caused any noticeable injury, though often observed as occurring in limited numbers, but this year it became so abundant as to seriously damage all the patches of Rape on the college grounds. The worms are so well protected in folds of the plant leaf and many of them on the under side that they are difficult to kill, and sprays of London purple were only partially successful, and it seemed that this poison applied in the form of powder diluted with flour and blown among the leaves was more effective.

The Cabbage Plusia (*Plusia brassicæ*) was also plentiful and accompanied the preceding species in their attacks on Rape, Cabbage, etc. For a time they caused more injury than that species. They were, however, attacked by a disease that swept many of them off, so that their damage was perhaps not so important in the aggregate as that of the preceding species.

The Imported Cabbage Butterfly (*Pieris rapæ*) was not seen at all in the early part of the season and it was thought that the *Apanteles glomeratus* mentioned in last season's report had accomplished a thorough work; but late in August and early in September butterflies appeared in large numbers and larvæ were fairly plentiful in some cabbage patches during October. Of course the scarcity during the fore part of the season may have been due to the previous abundance of parasites, but it shows that such parasitism does not furnish a permanent check. Specimens received from Des Moines were abundantly parasitized with *Pteromalus puparum*, and this species, with the *Apanteles glomeratus* and the epidemic disease that occasionally sweeps them away, certainly conspire to assist greatly in the reduction of damage from this widespread pest.

Specimens of the larvæ of the Army Worm (*Leucania unipuncta*) were received from Muscatine County with the information that they were injuring crops in a considerable area in that county, but as they were evidently full grown probably their injuries ceased almost immediately afterward, so that I have no further information as to injuries from them or of their being present in any other localities in that part of the State.

The Clover-seed Caterpillar (*Grapholitha interstinctana*) was again plentiful and caused a considerable loss in the clover crop. This species feeds readily on the leaves or in the crown of the plant and so does much injury aside from its destruction of the clover seed.

A common Pyralid moth related to the species of Crambus, the *Nomophila noctuella*, was extremely plentiful in grass land during early October, swarms of them being seen in all pastures and meadows. In a previous report I have called attention to this species as a probable serious pest in grasses, with habits similar to those of Crambus, and the observations this season on the numbers of the adults and their habits confirm my opinion that they have larval habits similar to Crambus and that they must cause a serious loss in pastures and meadows. Work upon other species has precluded any effort to trace the larval history the past season, and so far as I am aware nothing has been recorded with regard to it. It seems to me well deserving of investigation. The imagos of *Crambus exsiccatus*, a species which has heretofore been reported upon, with details of its life history, were plentiful this season, but not in such numbers as in some former years. Still they may be counted as among the very constant destructive species.

Edema albifrons was quite plentiful on Oak, and has been received from other localities, and would seem to be more than ordinarily destructive this season.

The larvæ of quite a number of Lepidoptera that are usually rather scarce or inconspicuous were during autumn quite abundant. Among these I may mention *Papilio cresphontes*, which, though usually very rare here, was taken in considerable numbers upon Prickly Ash. *Mamestra picta*, generally rare here (which may sound strange to entomologists in some other localities), was fairly common, though not to be counted a destructive species. *Actias luna* was quite common and many specimens were brought in by students. Also *Hyperchiria io*, very seldom seen in any great numbers, was found in considerable numbers. *Datana angusii*, as usual, was abundant, and *Grapta interrogationis* and *Vanessa antiopa* were conspicuous in their attacks. The common species, *Papilio turnus* and *Papilio asterias*, were more abundant than usual, and in some cases did damage to their respective foodplants.

At the meeting of the Association of Economic Entomologists held in August I reported some notes on the life histories of certain Jassi-

dæ which have been noted as specially destructive in this State, and which have a general distribution over the country. Since these have a general importance and some further details have been worked out since the presentation of that paper, I will venture to repeat briefly the facts as at present available.

A quite important step has been gained in the determination of the winter conditions of the strictly grass-feeding species, notably *Deltocephalus inimicus*, *D. debilis*, and *Diedrocephala mollipes*. These all deposit eggs in autumn in the leaves or stems of grass and the eggs remain in such situations over winter, hatching in spring.

The suggestion made in my report for 1889 (Bulletin 22, Div. Ent., U. S. Dept. Agriculture) is therefore well founded, and the burning over of grass land in late fall or early spring, when the grass is dry enough to burn down to near the surface of the ground, should prove a most effective and inexpensive method of treatment for pastures and meadows to reduce the numbers of these pests.

The life histories of the most common and abundant species may now be summarized as follows:

Deltocephalus inimicus.—Larvæ hatch from eggs deposited in fall, the larvæ appearing when fairly warm weather begins—ordinarily in April. The larvæ is at first light colored, but after the first molt has a black lateral border, a character by means of which it can be readily separated from *debilis*. These larvæ mature by the latter part of June, and imagos are plentiful during the last of June and fore part of July, becoming scarce again the latter part of that month, but depositing eggs which hatch in July and early August, and larvæ are very plentiful during early August and mature during the latter part of that month and early in September. This brood deposits eggs which remain over winter, though some of the earlier deposited eggs probably hatch in the fall and produce a late brood of larvæ, some of which seem to mature, and this probably accounts for the numerous individuals sometimes to be seen on warm days in late autumn and early winter. These seem to all perish before spring and probably without depositing any eggs. There is naturally a considerable amount of irregularity in the first appearance of adults and the time of egg deposition, but as these broods observed in the field have been paralleled with laboratory breedings there can remain little doubt as to the normal number and the time at which the bulk of the broods appear.

Deltocephalus debilis has practically the same life history, except that the broods appear about two weeks earlier, so that some adults will be found at the time the majority of *inimicus* are nearly grown larvæ. This makes it possible to use the tar pan at the time when the greatest numbers may be secured, which for most seasons will be at the time of the appearance of larvæ of both species, in late May and early June, again in early July, and a third time, if necessary, late in July or early in August. Of course applications will be made with reference to times

when larvæ or adults are noticed as hopping abundantly, and it seems from results of this season's work that the greatest numbers of hoppers are captured in the afternoons of warm days, with little or no wind, the hoppers seeming to jump best between 3 and 6 p. m.

Further tests of the tar pan have confirmed its value in destroying these pests, and a field test made with the coöperation of the farm department of the Experiment Station, and reported in full in Bulletin 19, Iowa Experiment Station, has shown that its use will practically enable the farmer to keep a larger number of cattle, sheep, or other animals upon grass land. In the experiment referred to, the result showed a gain of 68 per cent, but inasmuch as the experimental plat lay alongside other grass land and was subject to invasion from this, it seems to me that by a continued use of the treatment and over whole pastures, so as to preclude migration of insects from adjacent areas, we would get a still better result, and while it is perhaps too much to hope to get an increase sufficient to double the number of animals pastured on an ordinary field, I should hope to secure some such proportion, at least, if other destructive insects were also kept within bounds.

Another very widespread and destructive species is the *Diedrocephala mollipes*, and this has been the subject of a thesis study by Mr. J. A. Rolfs, a senior student in entomology here this year. The main facts in its life history may be stated in brief in this connection. The eggs in fall are mostly deposited in the rank grass of low ground, the insects preferring low ground during dry weather, which usually prevails for a few weeks in autumn. The larvæ hatching in spring, during May or early June, become adult by the latter part of June or early July, and in ordinary seasons will largely migrate to higher ground and deposit eggs, so that the second brood of larvæ, which appears in September, for the most part will be found widely distributed on both high and low ground, and may cause great damage. These larvæ mature by early October, and the imagos will, many of them, move to low ground to deposit eggs. It is evident that the burning over of sloughs and swampy or low ground is very desirable in the treatment of this species.

Plant-lice have been very plentiful during the autumn months, a strong contrast to their scarcity during the early part of the season. I had hardly returned from the Rochester meeting, where I reported a scarcity of these insects, when they became very conspicuous in their abundance.

Myzus persicæ on wild plum trees was among the species most noticeable, but the injuries it caused were by no means so severe as occurs when it is abundant in the early part of the season and attacks the growing twigs and the fruit.

Aphis brassicæ was specially noticeable on Rape, where it caused a considerable amount of damage, rendering the crop unfit for feeding. It was quite numerously infested with parasites in late autumn.

Many other species were abundant, and especially during October hosts of individuals were seen migrating from their summer locations to the plants which support their winter eggs. On some of these observations were made, but they can best be included in a discussion of the species in detail when their full life histories are worked out.

Last year I made a trip for the Division to western Kansas to investigate a local outbreak of grasshoppers, a report of which, with the recommendations suggested, was published in INSECT LIFE, vol. IV, p. 49.

Naturally, I was interested to know the outcome for the present season and wrote to parties in Garden City and Lakin, asking for a statement as to the abundance and injuries and what steps, if any, were taken in destroying them. I received two letters, from which I extract the following:

GARDEN CITY, KANS., *August 20, 1892.*

DEAR SIR: The grasshopper has been quite bad in localities. I think, from reports, that it will do almost as much damage as last year in the aggregate. On a few farms the wheat was injured and oats entirely destroyed—probably not more than one-half crop at the best. Farmers report that the fly is not killing many of them. Machines were made for capturing them. Some report large numbers taken.

ANDREW SABINE.

LATER.—Since writing the within I have been making inquiries and find that the hopper has been destructive only in spots. Wheat has not been injured. Some fields of oats destroyed. In other places only a few acres would be destroyed. They are commencing to disappear. Some say that they are dying rapidly. I met no one who had looked for the cause of death. Toads were innumerable this year—so much so that "everybody" was talking about it. I think the damage this year will fall much below that of 1891.

A. S.

LAKIN, KANS., *August 7, 1892.*

* * * As to the number of hoppers I see very little difference from last year. By far the most damage has been done by *Melanoplus differentialis*. I send you some hoppers caught this morning; also some dead ones found on asparagus. You can judge from the stalks the effect that they have had on that. There is a little green growth on the bottom yet. Parasitic Tachinids have destroyed more than last year. As to fighting them very little has been done, and that in a half-hearted way. I cleaned them out of the orchard wherever I cultivated the ground early enough and solidly. Am satisfied that they can be caught on the alfalfa by hopper-dozers. We have had some trouble in getting pans made, but they are bound to work if taken in time.

These hoppers will be likely to stay and grow fat just so long as we give them a good breeding ground and plenty to eat. We had some cold wet weather last spring just as they were hatching, which checked them some, but they seem to have outgrown it. I find a good many young ones now.

J. W. LONGSTRETH.

Prof. H. OSBORN,
Ames, Iowa.

TESTS OF THE BOTRYTIS TENELLA ON LACHNOSTERNA.

During the spring we received from your office a tube of *Botrytis tenella* from France, with instructions to test it on Lachnosterna larvæ in this locality.

Four tests were made of the material, following the directions for preparing and applying that accompanied the tube. Two of these tests were made in the laboratory in small glass root cages and two of the tests were in outdoor plats.

In the first laboratory experiment, May 26, about twenty larvæ were treated, ten of which were inclosed in a root cage two and one-half by four feet deep, and ten in an outdoor plat. Examinations later showed no result.

At the same time a few treated larvæ were placed in a glass root cage, the earth in which had been sterilized by continued baking, and kept in the laboratory for the purpose of closer observation. One specimen included in this cage was found to be covered with a small cyst of earth filled with a mycelial growth and the larvæ itself was covered with a dense white growth of mycelia. Another grub in this same cage went on and pupated and showed no signs of being affected by its treatment nor from being in contact with the diseased larva.

On June 23d another test was made, both in laboratory and field. Twenty-three treated larvæ were inclosed in a glass root cage 24 by 36 by 3½ inches inside. This was filled with sterilized earth to within 6 inches of the top. The earth had been sterilized by heating in a hot air oven from six to eight hours at 70° to 90° C. These were examined August 28. Three live grubs were found and five beetles. A number of larvæ, with no signs of growth, were observed dead on the surface a few days after treatment, and it is probable that they had been slightly injured before or during collecting, as they were picked up in furrow after the plow. The outdoor experiment, as in the first case, gave no result.

It will be seen that the only successful inoculation was of a single larva in a laboratory cage, and this diseased larva did not communicate the disease to another in close proximity to it. The field experiments showed no result whatever, though it can not be said but that larvæ became affected and escaped our notice in later examinations and that the disease may appear hereafter.

The tubes evidently contain a small proportion of spores and a large proportion of starch, so that it is possible the larvæ did not all get an inoculation with spores.

ENTOMOLOGICAL NOTES FOR THE SEASON OF 1892.

By MARY E. MURTFELDT.

LETTER OF SUBMITTAL.

KIRKWOOD, MO., *November 2, 1892.*

SIR: I herewith submit such of my entomological notes for the past season as relate to species of economic importance, including accounts of a few species that have not hitherto been included in that category. I have been much interested in the study of several other species, also pernicious or beneficial, but as these have not yet reached full development, I beg to reserve my notes upon them until I shall be able to complete the record.

Respectfully,

MARY E. MURTFELDT.

Dr. C. V. RILEY.
U. S. Entomologist.

MISCELLANEOUS MEMORANDA.

The climatic peculiarity of the past season throughout the Mississippi Valley was found in the excessive rainfall and the low temperature of the spring and early summer. That these conditions would produce a noticeable effect upon insect life can not be doubted. Wheat fields and corn lands that were inundated during April and a part of May, so far as I have been able to ascertain, entirely escaped attack from Chinch Bugs and Bill Bugs. I am also inclined to ascribe to the same cause the somewhat remarkable non-appearance of the Colorado Potato-beetle over a wide area of the country. So absolute was this disappearance that repeated and careful search in this locality for specimens upon which to test insecticides failed to reveal a single beetle or larva. I can not say, however, that the potato crop was the better for this immunity. The plants seemed sufficiently vigorous, but the tubers were few and small and the crop in Missouri almost a failure.

Another insect that seems to have mostly deserted this section of the country is the Grape Phylloxera. For two or three seasons I have not noticed any galls on the leaves of even the most susceptible varieties, and examinations of the roots of Delaware, Taylor, Catawba, and

Herbemont have shown them to be free, or almost free from the subterranean form of the pest. Such old vines of the above and other delicate varieties of the fruit as had been suffered to remain in some of the vineyards around Kirkwood, have, for the last two years, renewed their vigor and borne good crops.

Flea-beetles gave very little trouble where gardeners had been careful, during previous seasons, to eradicate such weeds as Lepidium and Arabis from the neighborhood of their vegetable beds, since it is in the leaves of these that *Phyllotreta sinuata* Steph., with us by far the most abundant and destructive species, chiefly breeds.

The Cabbage Curculio (*Ceutorhynchus rapæ* Gyll.) occasions much loss and annoyance to market gardeners in some parts of the State, by boring into the crown and roots of young cabbage and cauliflower plants, in many cases destroying 25 per cent of the plants in the hotbeds and just after they are set out. As this insect does not trouble the plants after the heads begin toform, I was at a loss to conjecture what became of it during the summer and autumn. From experiments conducted this year I am convinced that it returns to its original food plant, the wild Pepper-grass (*Lepidium virginicum*). I succeeded in obtaining young larvæ in stems of the latter plant in July, but as the plants did not thrive indoors I was unable to bring the insect through its transformations.

Disonycha collaris is establishing its title as a spinach pest, its perforations being seen during April and May in almost every leaf of that highly esteemed pot herb. As both beetles and larvæ drop to the ground upon the slightest disturbance of their food-plant they are seldom associated with their destructive work.

The foliage of roses in Kirkwood and vicinity suffered this summer from the attacks of all three of the species of sawfly larvæ described in vol. v, INSECT LIFE (p. 6), *Cladius pectinicornis* being very numerous and reducing the leaflets on some bushes to mere shreds. An infusion of white hellebore proved an effective remedy, but the necessity of applying it at intervals throughout the season adds materially to the labors of the rose-grower.

The Twelve-spotted Diabrotica appeared in countless numbers in flower gardens during September and October, and wrought ruin on the blossoms of dahlias, zinias, cosmos, and early chrysanthemums. To kill it on the flowers, or render them distasteful to it, involves the sacrifice of all the beauty of the latter, by spraying with the arsenites or kerosene emulsions. Where the insect breeds in such swarms I have not been able to discover. Certainly it was not in any of the corn fields around Kirkwood, for I uprooted a large number of plants in the immediate neighborhood of our flower garden without finding any trace of larvæ or pupæ. I think its native and favorite food-plant remains to be discovered. Another unmanageable pest, of which there is complaint is the the Corn Ear-worm (*Heliothis armiger*).

It shows a marked partiality for the sweet table varieties, of which it destroyed in the gardens around St. Louis between 25 and 30 per cent of the ears.

The Tineidæ as well as the larger Lepidoptera contribute their full quota of species injurious to growing vegetation, in addition to those that prey upon stored grain and household property. Among the former the Box-elder Gracilaria (*Gracilaria negundella*) was exceedingly abundant during the past season in this locality, the leaves of the favorite shade tree upon which it feeds being thickly spotted with its preliminary mines and having almost every lobe turned down to form the three-cornered tent, within which the larva feeds after its first molt. Many of the cocoonets of the latest brood were parasitized, however, and it may not another season prove so disfiguring to the trees.

ADDITIONAL INJURIOUS INSECTS.

The Osage Orange Pyralid

(*Loxostege macluræ* Riley.)

Among the insects that are to be recorded for the first time with "noxious species" the one named above has, in this section of the country, acquired especial prominence.

Its work was first observed upon the hedges of Kirkwood and vicinity in the autumn of 1890, where for a few yards in a place the twigs and branches appeared nearly denuded of foliage. Examination failed to reveal the author of the mischief, and it was attributed to some Orthopteron, especially to those of the Tree Cricket family. The following year its ravages were seen on all the hedges of the county, greatly impairing their beauty. Late in summer the pest was discovered, and the habits by which it had so long eluded my search brought to light. During the present year its work has been increasingly destructive, and unless concerted action is taken for its extermination the hedges of the Mississippi Valley will no longer be either ornamental or useful.

The depredator is a small, glassy, pale green caterpillar, more or less gregarious, especially during the first larval stages. It is the young of a rather inconspicuous Pyralid moth, new to this region, if not to science, which may be popularly described as follows:

Expanse of wings nearly seven-eighths inch, or 24^{mm}. Fore-wings satiny in texture, of a pale brownish-gray color, sometimes, when the insect is perfectly fresh, faintly tinged with green or roseate, and always crossed by three curving, wavy, interrupted, dusky lines; the outer margin back of the very short white fringes being also dark. Hind-wings similar in color to the fore-wings, but thinner, without the dark cross lines, but with dusky shadings on the lower edges. Body, brownish-gray above, satiny white beneath. Head narrow, with projecting, beak-like palpi, margined with white, very long tongue, large hemispherical eyes of a mottled, dark-brown color, and slender, tapering, threadlike antennæ three-fourths the length of the wings. The abdomen is very slender, and somewhat constricted or laterally compressed, with long terminal joint upturned. Legs long, of a glistening white color.

These moths emerge in spring from the first to the middle of May, and may be seen on warm evenings fluttering in great numbers about the hedges. They are not much attracted by lamplight, but occasionally one enters a lighted room. The eggs are laid on the under sides of the Osage Orange leaves in irregularly shaped masses of from twenty-five to fifty. They are circular, very flat, pale yellow, and each has a delicate semitransparent membranous border. Like those of certain other Pyralids, they overlap, fish-scale fashion, and as the embryo develops each egg displays two minute black marks or lines. The larvæ hatch in five or six days, and, unless disturbed, remain in a close cluster, feeding upon the parenchyma of the under side of the leaf, which surface they closely resemble in color. At the slightest jar they curl up and drop to the ground. In six days the first molt takes place, and, if they have not sooner exhausted their food supply and been forced to scatter, they now migrate in small companies to fresh leaves, which, in feeding, they begin to perforate. When not feeding they stretch themselves alongside the midrib and principal veins, where their translucent, pale green color and very slender form enable them to escape observation. As they approach maturity they become still more elusive, retiring from the leaves during the day and resting upon the inner twigs and stems, which their coloring at this period usually imitates. They spin considerable web upon the under sides of the leaves, and draw out the threads as they crawl back and forth from the stems to the leaves. In these webs and threads more or less of the castings are caught, and add to the disfigurement of the plant.

Larva.—The full-grown larva is from eight to nine-tenths of an inch long (20 to 24^{mm}) by about three-twentieths (4^{mm}) inch in diameter in the middle when crawling. It is somewhat contracted and broadened in repose. The form is subcylindrical, tapering slightly toward either end. The color at this stage is variable, in some specimens translucent pinkish, in others dull green, and again of the gray-brown shade of the twigs, always obscurely striped on the dorsum and sides with a darker shade of the ground color, and having a narrow, but distinct, ivory-white stigmatal band. Piliferous dots black, surrounded with a paler ring, largest just above stigmatal band; four in subdorsal spaces on eleventh segment being in the hollow of conspicuous crescents, convex toward the sides. Head narrower than thoracic joints; cordate, with rounded lobes of a pale brown color, with irregular stripes in a slightly darker shade, trophi fuscous. Legs and prolegs concolorous with general surface.

The cocoon in which the worm incloses itself for transformation is of irregular shape and fits the chrysalis very loosely. It is of a fine texture and pale pinkish or dingy white color. The summer broods change to chrysalis soon after inclosure, but the hibernating one remains in the larva form until late in winter. The chrysalis is from 12 to 14^{mm} long, very slender, with slight corrugations on the posterior edge of the segments, and of a bright brown color. The cocoons are formed, sometimes several together, among the webbed and fallen leaves on the surface of the ground. At this date (December 1) the hibernating larvæ are somewhat shrunken and all of an opaque yellowish-white color, on

which the fuscous dots, rings, and crescents are very prominent. I have learned of the presence of the insect in one or two counties besides St. Louis, and have reason to think it quite widely disseminated, although not so destructive to hedges in more sparsely settled localities as it is in the various suburbs of St. Louis. Thorough spraying with any of the arsenites will kill it, but the process needs frequent repetition during the season, and much pains must be taken to wet the inner as well as the outer leaves.

The principal enemy of this insect, in its own class, is the Spined Soldier-bug (*Podisus spinosus*), of whose larvæ and pupæ I found a large number at different times with their beaks inserted in the bodies of the wriggling larvæ. A few larvæ were also destroyed by the small Ichneumonid, which was kindly determined for me at the Department as *Bracon juglandis* Ashm.

The Blue-grass Worm.

(*Crambus teterrellus* Zinck.)

For two or three years the moths of this species have in this locality outnumbered all the other species of Crambids combined. In the daytime they would flutter up from the grass before us at every step and at night our lighted windows would be covered with them. About the first of August, when these moths were most abundant, I had occasion to dig up a bit of sod from the lawn, and upon examining it closely I found several galleries of fine white web, with sparse minglings of castings formed against and between the stems and blades of the grass. In each of these tubes was a minute, dingy white larva, then 4 or 5^{mm} in length. This piece of sod was carefully planted in a large rearing jar and watered, so that it might continue to grow. A day or two after this a considerable number—eighteen or twenty—of minute, salmon-colored eggs were found on a window-sill near a dead specimen of the moth above named. By means of a fine camel's hair brush these eggs were transferred to a glass tube containing several blades of grass, and in the course of two or three days about a dozen tiny larvæ, of a cream-white color, with brown heads, had hatched. Placing them upon growing grass, they soon began the formation of tubes or galleries similar to those taken out of doors, and as they continued to develop, it was plain that they were identical with the latter.

During the dry weather of August and September others were found on the lawn, where the grass had withered in small patches, and it was evident that to this species is due to a considerable degree the faded appearance and scanty growth of the blue grass during the latter part of summer.

The growth of the larvæ was very slow and seemingly out of all proportion to the amount of web tubing constructed. A single larva, not more than one-third of an inch long, seemed to require for its domicile

a gallery 2 or 2½ inches in length, and with a diameter two or three times in excess of its own. The upper part of this tube would be exceedingly diaphanous, but as it descended more and more of the brass was intermingled until at the base it became quite compact. During the day the larva rested quietly in this retreat, but at night it emerged and fed upon the freshest of the contiguous blades. So far as I could ascertain it seldom or never cut through the stalk or bored up or down through the heart of the plant.

The larvæ seemed to attain maturity from the middle to the last of September, after which they rested quietly for some time in their galleries, without inclosing themselves in more protective cocoons.

Being absent from home for four or five weeks, from early in October until the middle of November, my jars were overlooked in the watering process, and upon my return I found all the larvæ dead and dry. As the species was known to me, however, this was not so unfortunate as it might have been.

In the jar containing specimens collected at various ages from the lawn were the remains of two or three hymenopterous parasites and four cocoons of the characteristic form, color, and structure of *Meteorus*, closely resembling those of *M. hyphantriæ*.

I append more particular description of egg and larva.

Egg.—Obconical 0.5^{m} long, beautifully sculptured under the lens, with longitudinal ridges and finer cross lines, giving it a checkered appearance. Color, bright salmon pink.

Larva.—At first of a dingy cream white, minutely speckled with brown, with brown head.

At maturity 15^{mm} in length, by 2^{mm} in diameter, subcylindrical, slightly larger across thoracic segments.

Color dingy yellowish or greenish white, with dull green medio-dorsal stripe. The surface is much roughened with impressed lines, with conspicuous, raised corneous, fuscous plates, from each of which arises a long, coarse, tapering, golden-yellow hair. Head with protruding lobes and rugose surface, and of a dull whity brown color. Cervical shield inconspicuous, darker than the head.

Pupa not yet observed.

The moth is well known as one of the least conspicuous of the group of beautiful species to which it belongs. It expands about three-fourths inch, with a brownish-white body and hind-wings. Fore-wings grayish-white, streaked with pale brown, with two silvery gray shaded wavy lines crossing the outer third; just back of the fringes, which have a golden, metallic luster, is a row of seven small but distinct black dots.

Lasioptera sp? in Twigs of Honey Locust.

The work of the above Cecidomyiid was first noticed in the summer of 1891 on the shoots and new growth of the Honey Locust, a shade tree of considerable value with us, and during the past season it became more and more injurious and conspicuous. The irritation of the plant

tissue produced by this insect causes remarkable tumefaction and distortion of the twigs and scantiness and yellowing of the foliage, resulting in a complete checking of growth.

The perfect insect is a minute fly or gnat, expanding about $\frac{1}{8}$ inch, having a glossy black body and broad transparent fore-wings, with a rather strong marginal vein, and a faint, forked vein on the lower edge. These gnats emerge from their cells early in May and lay their eggs (which I have not so far been able to detect) on the succulent new growth of the tree into which the microscopic larvæ easily burrow and begin the formation of their cells, very shortly producing gall-like swellings and twisting of the stems. These cells, each about $\frac{1}{8}$ inch long, and oblong in shape, become, as the season advances, exceedingly compact, almost stony, and in some cases almost fill the shoots for a space of from 5 to 7 inches in length. They are placed longitudinally, and a cross-section of a twig one-fifth inch in diameter will often cut four or five, although they are seldom regularly arranged side by side. The larvæ attain their growth in July or August, and remain unchanged in their cells until the following spring. They are at this time from three to four millimeters in length by one in diameter, cylindrical, with segments well defined, of a bright salmon-pink color, with conspicuous "breast-bone" in dark brown.

The outlet to the surface is probably by the passage through which the larva worked its way within the stem, though in what way extended, to admit of the egress of the much larger pupa, I can not tell. At all events when ready to emerge the pupæ are protruded, sometimes singly, in other cases in clusters of three or four where the larval cells have coalesced, from minute orifices all along the stem, giving it quite a fringy appearance with the erect translucent white empty pupa cases.

Two species of parasites have been bred from these Lasioptera galls, and examinations of infested twigs within a few weeks discloses more larvæ of parasites than of the original gall-makers.

Diplosis sp? on Soft Maple.

This is a probably undescribed species, also a Cecidomyiid, which destroyed a considerable proportion of the very young leaves of Soft Maple in Kirkwood and vicinity early in the spring. The punctures of the insect caused a peculiar curling and shriveling of the leaves, and in every depression would be found a minute white larva not more than 2^{mm} in length and 0.5 in diameter across the anterior end, from whence it tapered slightly posteriorly.

The first brood of flies emerged in June from little flattened oval cocoonets spun against the surface of the leaves. A second brood appeared late in July rolling the edges and crinkling the centers of the more tender leaves, but was far less injurious to the appearance of the trees than the earlier one.

Still another Cecidomyiid, of which I did not obtain the fly, attacked the foliage of the sugar maples in Kirkwood, curling and producing a gall-like thickening of the edges of the leaves. The affected portions turned crimson and gave the foliage the appearance of being covered with long, slender, red worms.

My attention was not called to this insect until it was too late to learn its natural history or to attempt the use of any remedy.

SCARCITY OF PARASITES OF CODLING MOTH AND PLUM CURCULIO.

Having always had some misgivings that in the practice of spraying fruit trees with the arsenites, we were destroying our most valuable allies in our warfare with the above-named pests, I made it a point during the past season to ascertain what proportion of them were really parasited.

Infested fruit was collected from an unsprayed orchard at intervals throughout the season, and both Codling Moth and Curculio bred in considerable numbers with a result that 4 per cent of Curculios were parasited, and from about one hundred Codling Moth larvæ not a single fly appeared. As the deluge-like rains of the spring and early summer may have had something to do with this unexpected result, I propose to repeat it another year, and hope to make a more satisfactory report.

EXPERIMENTS IN APICULTURE, 1892.

By J. H. LARRABEE.

LETTER OF SUBMITTAL.

AGRICULTURAL COLLEGE, MICH., *November 17, 1892.*

SIR: I beg leave to submit herewith a report upon the experimental work in apiculture conducted at this place during the season of 1892. While the results obtained may vary with varying conditions, either more or less favorable than those under which these experiments have been conducted, yet it is hoped that some of the conclusions reached may prove of definite value to the important interest of apiculture.

Very respectfully,

J. H. LARRABEE.

C. V. RILEY,
U. S. Entomologist.

During the season of 1892 the branch station for experimenting in bee culture at the Michigan Agricultural College was continued at the expense of the U. S. Department of Agriculture, Division of Entomology, and of the Michigan State Experiment Station.

An effort was made to undertake a line of experiments closely connected with the practical work of the apiary. While all of the experiments undertaken have not given results of practical value, some have. Especially gratifying are the results obtained in the experiments upon the subject of wax secretion and the evaporation of honey, for the reason that they were nearly free from those elements of uncertainty that must necessarily enter into nearly all experimental work in the apiary, such as season and condition of bees.

When the bees were taken from the cellar, on April 18, they were in rather poor condition, due doubtless to the dampness of the cellar and the character and amount of the stores. The loss during the winter and spring was about one-third of the number placed in the cellar.

In May and June the bees of the whole apiary were transferred from the old hives into modern dovetailed hives, and from the old reversible frames, of three distinct sizes, to the new, wide, thick, top-bar frames of the Langstroth size. In this operation all drone comb or other imper-

fect combs were rejected and rendered into wax. By this change the apiary was placed upon a modern footing, the hives made uniform, the operations and manipulations of the apiary rendered more rapid, and its beauty and value increased.

The spring was very backward and rainy. During fruit bloom the bees flew but little, and their influence upon the fertilization of the flowers of our fruits is seen in the almost complete failure in this vicinity of all tree fruits and others largely dependent upon the bees for the dissemination of pollen. As the rainy, cloudy weather did not cease until about the first of July, the early part of the clover bloom was lost to the bees. No supers were put on until July 8, and at that time strong colonies were swarming, with almost no honey in the hives. All of the white surplus was taken from Basswood, which yielded well. July 25 the season for white honey closed. A little surplus of late honey was gathered during August, and the bees filled up the hives well for winter. A yield of about 25 pounds of surplus per colony was obtained, and there are now in the apiary fifty-five colonies in excellent condition for winter.

BREEDING.

During the year 1891 the apiary was entirely requeened, only a few old queens being reserved for breeding. This season the opportunity was taken to replace all those of the former year's rearing that had proven themselves inferior. A number of Carniolan queens were introduced, and queens bred from them. Added familiarity with the cross of the Carniolan bee with the yellow race increases my satisfaction with their valuable traits. They have proven themselves equally as desirable as either race in its purity, and they have some points of superiority.

A test was made of the claims advanced for the Tunisian or so-called "Punic" bees. During the early part of the season they exhibited no traits that would distinguish them from the native black bee, showing the same nervousness under manipulation. They build large numbers of queen cells, and do not cap their honey with that peculiar whiteness characteristic of the common black bee. After the close of the honey season they best showed their origin and distinctive peculiarities. Whenever attempts were made to handle them they became exceedingly angry. This trait of excessive irritability seems to be their most distinctive mark. As no point of superiority was discovered, their several manifest defects make them a race not to be recommended as desirable for introduction among our American bee-keepers.

REMOVING THE QUEEN TO PREVENT SWARMING.

As the bee-keeping industry develops and new methods and devices come into use, each tending to lower the price of the product, an increased tension is placed upon the apiarist in an effort to manage large num-

bers of colonies to increase his annual yield. The natural tendency of bees to increase by swarming and the care and attention occasioned thereby have given rise to various plans for its prevention or control. One of the best of these plans, yet one little used, is outlined in the following, the value of which, at the suggestion of Mr. Aikin, of Loveland, Colo., I undertook to test: Early in spring two colonies were selected, as nearly alike in strength as it was possible to get them. These were kept at the same strength, the amount of brood in the hives having been equalized several times. The harvest did not open until about July 6, and upon the 8th supers were given them. July 12, queen cells were found partly constructed in colony No. 1. The queen was removed, and four days and also eight days afterward all queen cells were destroyed. On July 25 (thirteen days after her removal) the queen was returned. This colony did not swarm at all. The other colony (No. 2) was allowed to work without interference, and it was not until July 21 that they swarmed. As the harvest from Linden was about closing, the swarm was returned and all queen cells destroyed in the hope that they would not attempt to swarm again before the close of the season. They did not swarm, yet it may be supposed that this interference with their instincts tended slightly to decrease their energy. The results in total amount of honey gathered are as follows: No. 1 gained in weight 37 pounds between July 6 and 25, and No. 2 gained 46 pounds during the same time.

If from the total gain of No. 2 we substract 5 pounds as the weight of brood it contained in excess of the brood in No. 1 on July 25, we still have 4 pounds as the amount of honey gathered by No. 2 greater than the amount gathered by No. 1. These colonies were both worked for comb honey with like treatment of supers.

This experiment is valuable testimony to prove that the removal of the queen to prevent swarming does somewhat affect the amount of honey gathered by the bees. The supers showed even a larger difference in the amount of honey stored in the sections for the reason that where the queen is absent the bees fill the brood chamber with honey. When the queen is returned this will to a greater or less extent be removed to the sections. Although the interference in this manner with the economy of the hive probably always reduces the amount of honey stored, yet because of the lessening in the labor and watching necessary during the swarming season, I deem it advisable to follow this method when any similar plan seems necessary.

WAX SECRETION.

To determine the amount of honey consumed by the bees in secreting one pound of wax, this experiment, first undertaken in 1891, was repeated this year. As the conditions were much more favorable, the results were very gratifying. There was entire absence of a natural honey flow, the weather was favorable, the colonies were of the same strength,

and in prosperous condition, they took the food rapidly and built comb readily. The result gives a less amount of honey as necessary to be fed the bees in order to have 1 pound of wax secreted than was obtained in this experiment last year. This was to be expected because of the more favorable and exact conditions. Two colonies were taken which I have designated as Nos. 1 and 2. No. 1 was given a virgin queen and no comb or honey. No. 2 was given a virgin queen and empty combs. It was noticed that the bees did not fly from either of these hives as vigorously as from the others of the apiary, and that No. 1 was the more quiet of the two. Twenty-four and a half pounds of food were given, and almost exactly 1 pound of wax was secreted by No. 1. By weighing the combs both before and after being melted and taking the difference, the amount of pollen was ascertained. In both colonies the young queens had begun to lay, having been fertilized during the ten days the experiment was in progress. I now feel confident that more careful work on the part of others who have undertaken to solve this question will give practically the same results as are summarized below:

Wax Secretion.

	Colony No. 1.		Colony No. 2.	
	Lbs *Oz.*	*Lbs.* *Oz.*	*Lbs.* *Oz.*	*Lbs.* *Oz.*
Weight of bees	7 5	.....	7 3	.....
Gross weight, Aug. 2, with bees	.....	27 8	.....	34 4
Gross weight, Aug. 12, with bees	.....	42 10	.....	56 8
Gross gain in weight 10 days	.....	15 2	.....	22 4
Feed given	24 8	.....	24 8	.....
Minus honey extracted	12 8	.....	20 8	.....
Leaves honey consumed	12	.....	4	.....
Honey consumed by No. 1 in excess of No. 2: 12−4=8 pounds	.....	.....	.....	.....
Wax secreted by No. 1	$15\frac{1}{2}$	.....	.....	.....
Pollen in combs at close	1 8	.....	2 ..	.....
Honey, wax, and pollen removed (8 pounds honey consumed in secreting $15\frac{1}{2}$ ounces of wax	14 $15\frac{1}{2}$	.....	22 8	.....

PLANTING FOR HONEY.

There were in bloom at the station this season three acres of Sweet Clover (*Melilotus alba*) sown in June, 1891. It was sown upon rather poor clay soil, yet it made a fair growth last fall and came through the winter in good condition. It began to bloom July 8, and continued in bloom until the 20th of September. The period of greatest bloom and honey secretion was from July 20 to September 1. It grew rapidly and was very rank, reaching a height of about six feet. The amount of bloom was great and the bees were continually busy upon it, yet during the period from July 24 to August 10, while it was in full bloom and while all other natural sources were absent, no honey of any appreciable extent was gathered and the hive upon scale lost in weight. Probably some honey was obtained during the season from this sweet clover, but in such limited quantities as to make any estimate of the value of the plant as a honey producer impossible. At the present time the

ground is covered with brush, so that labor will be necessary in clearing the land before plowing can be done.

With the idea of obtaining an opinion of the value of Sweet Clover as a silage plant an alcohol barrel was filled with the cut stalks, solidly packed, and sealed air-tight. This was done on July 14, just as the clover was getting fairly into bloom and while the stalks were yet tender and nutritious. On September 23 the barrel was opened and the ensilage was fed. A horse that had previously eaten corn silage ate it very readily, but another horse and a cow that had never eaten silage would not touch it. Several experts upon the subject pronounced it excellent. There is no doubt but that it would be a very desirable plant for the purpose if the feeding value per acre could be made equal to that of corn. An estimate made from the amount cut for silage gave between 6 and 7 tons per acre. Although its feeding value may be much higher than that of corn, it is still doubtful if it will pay to use it for this purpose alone, from the above estimate.

In concluding these experiments in planting for honey carried on by Prof. Cook and now concluded for the present, I desire to say that no results have been obtained with any plant sown or planted for honey alone that will warrant the bee-keeper in expending money and labor in this direction. Bee-keepers have in the past spent much time and money in the effort to cultivate some plant for the honey the bees may obtain from its flowers. In no case coming under my observation have these efforts been a success and the practice has never been continued at a profit. Therefore let me caution all apiarists against spending money in the attempt to cultivate at a profit any flower for honey alone. Bee-keepers should cease these useless efforts and turn their attention more persistently to extending the area of all wild honey-producing plants and urging upon all the superiority of Alsike Clover and Japanese Buckwheat as farm crops and the Linden as a shade tree.

EVAPORATION OF HONEY.

Nectar of flowers taken into the stomach of the bee undergoes certain chemical changes before it is finally deposited as honey in the cells of the honeycomb. The recent analyses, by direction of the United States Government chemist and those instituted at the Michigan State Experiment Station, prove that there is no chemical change made in the honey by the bee after it is deposited in the comb. There, however, remains much water in this honey that must be evaporated by the heat of the hive and the current of air through the hive caused by the fanning of the bees. It is well known that this labor of evaporation and the room occupied by this thin honey interferes greatly with the rapid gathering of nectar. In this opinion I am confirmed by a study of many records of colonies placed upon scales during the honey flow. It is often desirable to extract all of the honey gathered from one species of honey plant before the flow from other sources begins and before the

former has ripened to the usual consistency of good honey. The property of granulation in honey is so troublesome that its prevention would be very desirable. The experiments in this line have plainly indicated that the "water of crystallization" can be easily expelled by a proper artificial heat and the product sealed, so as to preserve it in a liquid state for an indefinite time. For these reasons it was thought best to experiment in this direction with various forms of artificial heat in the effort to devise some cheap and sure method to assist the bees in this work. For this purpose there were constructed a series of six shallow pans 19 by 28 inches in size, with partitions 2 inches in height, open on alternate ends, similar to the partitions in a maple-sirup evaporator. These were arranged in a cabinet, one above the other, so that honey entering at the top was obliged to flow some 75 feet before passing out at the bottom. An oil stove was placed beneath the whole, and a pipe at the top caused a current of heated air to pass upward over the honey. The fumes of the stove were carried off by means of a second pipe, in order to avoid all danger of their injuring the flavor of the honey. Honey of average body with 10 per cent by weight of water added was reduced again to the normal condition by passing twice through the pans at a temperature of 120°, and about 100 pounds per day was evaporated at that temperature. Thin nectar, extracted from the hives very soon after being gathered, was evaporated to the thickness of good honey at about the same rate. This apparatus was kept in operation about ten days upon honey of various thickness and upon clear water with the above definite results. The flavor of the first honey was injured—probably by the first acid action of the honey upon the outer coating of the tin. Afterwards this was not as apparent. The color was also somewhat affected.

The heat of the sun was also tried for purposes of evaporation. A shallow pan 28 by 54 inches in size was filled 3 inches deep with thin honey. This was covered with glass 6 inches above the honey and left in the sun for four days, when about 5 per cent of moisture was evaporated. As the honey lies at rest the water rises to the top, somewhat aiding evaporation. The flavor and color are not affected as much as by the method of running through pans. In this way honey with 30 per cent, and even 40 per cent, of water added was evaporated to the consistency of very thick honey in three weeks' time, so thick that it has not at this date showed any signs of granulation. During favorable periods of sunshine a temperature of 165° was reached. By this method a tank 4 by 6 feet, with 6 inches of honey and weighing 1,300 pounds, should be evaporated 10 per cent, or from the consistency of freshly gathered honey to that of average body, during about two weeks in July or August.

The common method of exposing to the air in open vessels in the warm upper story of a building was also tested with honey to which 10, 20, 30, and 40 per cent of water had been added. That having 40

per cent added became strongly fermented in a week's time, while only a slight change had taken place in the 30 per cent dilution, and at the end of a month it tasted like a very poor quality of commercial extracted honey or like honey dew. The 20 per cent dilution was not nearly as bad, and the honey, with only 10 per cent of water added, was during the month returned to the consistency of very fair honey.

Nectar extracted two or three days after the combs were placed in the hives contained, during the dry weather of July and August, from 10 to 15 per cent of water above the amount always found in honey that has been sealed in the comb by the bees. This was determined by evaporating in test tubes in hot water.

Summary.—(1) The method at present promising best results for artificial evaporation is that by solar heat under glass well ventilated. A small portion of a greenhouse or forcing-house arranged for conserving the heat of the sun, and so located that honey could be run into the shallow vats directly from the mouth of the extractor and drawn off from the bottom of the vats into marketing receptacles, should give good practical results.

(2) Very thin honey or nectar will not sour as quickly as supposed by many, and may be safely kept during any period of cloudy weather we may have during the hot summer months.

(3) The method of exposing to air in a warm room can not be depended upon to ripen very thin honey, although it may be serviceable for evaporating a very small percentage of water.

(4) The method of evaporating by artificial heat of stove or furnace is expensive and troublesome, requiring constant watching and care and not giving as good results as had been hoped for.

(5) The possibilities in the line of evaporating honey for the purpose of increasing the yield and preventing granulation are very great. A series of experiments to determine the increase in production by extracting freshly gathered honey would be next in order and value. When the utility of this method is fully demonstrated supers with fixed frames and extractors holding whole cases will be used and other apparatus conformable to the needs of the new system.

FEEDING BACK.

Feeding back extracted honey to secure the completion of unfinished sections at the close of the harvest is practiced by some apiarists, but with varying financial success. Extracted honey can be transported long distances with much greater safety than can comb honey. For this reason it has been thought it might be profitable to feed bees extracted honey costing 7 or 8 cents per pound to produce comb honey selling at 13 to 15 cents, locating the apiary designed for this purpose near a large city or other favorable market. With the idea of adding light upon this subject, extracted honey was fed to a number of colonies under the following conditions: The hives were contracted and the

queens kept in the brood apartment by means of excluding zinc. Five colonies were given two crates each of unfinished sections, the sections of the whole weighing 113 pounds. Three hundred and thirty-eight pounds of honey were fed these five colonies during twelve days. The honey was thinned with 12 per cent of water and warmed before feeding. The amount of finished honey obtained was 367 pounds, or a gain of 254 pounds by feeding 338 pounds of honey. The hives were weighed both before and after the honey was fed, and a gain of 36 pounds during the feeding recorded for the five hives. The following gives the results from a financial view:

254 pounds comb honey by feeding, at 14 cents	$35.56
36 pounds stored in hives, at 8 cents	2.88
	38.44
Minus value of 338 pounds fed, at 8 cents	27.04
Profit as pay for labor, etc	11.40

Two colonies were given crates of sections with full sheets of foundation and were fed extracted honey, under the same conditions as the five colonies above:

	Pounds.
Amount of honey fed each colony	66½
Colony No. 1, finished comb honey	41½
Colony No. 1, gain in weight of hive	9
Colony No. 2, finished comb honey	38
Colony No. 2, gain in weight of hive	7½

Taking these two colonies as a basis, the following financial statement is made:

79½ pounds comb honey, at 14 cents	$11.13
16½ pounds honey stored in hives, at 8 cents	1.32
	12.45
Minus value of 133 pounds honey fed, at 8 cents	10.64
	$1.81

Deducting from this profit the value of the sections and foundation used, the actual profit, as pay for labor, etc., is, at most, nominal.

When this whole experiment was begun, and during the time it was in progress, no honey was gathered from the fields, but before the sealing was all accomplished the fall honey flow began, and for this reason the experiment was ended and the honey removed sooner than would otherwise have been advisable.

The results obtained in this work or in any experimental work of a similar character might vary under more favorable or unfavorable conditions of environment, and a continuation in various seasons, and under other conditions, would alone give really reliable results. The above trials are, however, very encouraging, and longer and varied work in this line is desirable.

INDEX.

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