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U. S. DEPARTMENT OF AGRICULTURE.

Office of Secretary

Bureau of Entomology.

STUDIES

27
OF

PARASITIC AND PREDACEOUS INSECTS

IN

NEW ZEALAND, AUSTRALIA, AND ADJACENT ISLANDS.

MADE BY A. KOEBELE OF THE U. S. DEPARTMENT OF AGRICULTURE, BY
PERMISSION OF THE SECRETARY OF AGRICULTURE, AT THE REQUEST
OF THE CALIFORNIA STATE BOARD OF HORTICULTURE.

PUBLISHED BY PERMISSION OF THE SECRETARY OF AGRICULTURE.

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U. S. DEPARTMENT OF AGRICULTURE.

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[Report no. 51]

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LETTER OF TRANSMITTAL.

ALAMEDA, CAL., *September 1, 1892.*

SIR: I have the honor to submit herewith a report of my recent trip to New Zealand, Australia, and adjacent islands, which was undertaken by your authority and with the coöperation of the California State Board of Horticulture, for the purpose of studying the parasitic and predaceous insects of those countries, with a view to introducing the same upon the scale insects of California.

Very respectfully,

ALBERT KOEBELE,
Special Agent.

Hon. J. M. RUSK,
Secretary of Agriculture.

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PARASITIC AND PREDACEOUS INSECTS.

ACKNOWLEDGMENTS.

My thanks are due, in the first place, to Mr. Maskell, of Wellington, New Zealand, for kindly naming all the Coccidæ met with in my travels, which made my work much easier, as the various insects could thus be sent here with more accurate directions as to liberating upon the proper scales; also to Rev. Blackburn, of Adelaide, South Australia, for naming all the numerous known and unknown species of Coccinellidæ found in Australia. The descriptions of the new species will be published in the "Transactions of the Royal Society of South Australia," in which eleven new species found have already appeared. Credit is due to the gentlemen of the State Board of Horticulture for having so promptly taken the insects from the steamer on arrival and for having forwarded the same, on ice when necessary, to Los Angeles and Santa Barbara, while those that I wanted here were liberated upon such scales as directed; also, for having kept me informed as to the condition in which the insects arrived and the progress they made; especially to the president, Hon. Ellwood Cooper, who never failed to write with every outgoing mail, keeping me informed of the doings of insects received by him. Thanks to his deep interest in the matter and to the fidelity with which my instructions were carried out, he has succeeded so well that four of the most effective enemies of the Black Scale were already found breeding in large numbers at his place, during a two hours' search on August 4, 1892. Without doubt others will turn up in due course of time.

THE COLLECTION, FORWARDING, AND LIBERATION OF INSECTS.

Ten days were spent in the surroundings of Honolulu, four weeks in New Zealand, seven months in Australia, chiefly in New South Wales, and two months were consumed in a trip to New Caledonia and Fiji.

The first lots of insects (excepting those from Honolulu, which went to the State board) were all sent to Mr. Coquillett, at Los Angeles; later, duplicates were also sent to the State board for trial upon *Aspidiotus perniciosus* Comst. and other coccids found in northern California. Two lots were sent to Hon. Ellwood Cooper, at Santa Barbara, to be liberated upon the Olive Scale (*Lecanium oleæ* Bern.).

The insects collected were, as far as it was possible, placed in various boxes in the field, and upon these the contents were noted and directions given to liberate them upon such coccids as it was expected they would feed upon. In exceptional cases, where there was danger of introducing with them their natural enemies, I suggested that the insects be bred in jars. Experience has proved to me, both through close study in the field and breeding of coccinellidæ in the house, that the latter method is not practicable, is in fact almost useless, except with a very few species. Most of the Ladybirds will, if confined in jars, devour their eggs almost immediately after they have been laid. In reference to coccids with hard coverings this has been repeatedly observed, even in the field, where they had unlimited space.

Of about two hundred and fifty *Rhizobius debilis* Blackb., found feeding upon *Lecanium cassiniæ* Mask., infesting the olive trees at Adelaide, South Australia, which had to be kept in jars with those scales for some time, not one single larva could be obtained. Eggs were often noticed, yet always, and in a very short time, these would be devoured by the beetles. And yet this same insect, from only two specimens left in my garden at Alameda by Mr. Craw, upon *Aspidiotus perniciosus* Comst., infesting prune and peach trees, had increased within four months to such an extent that they had spread to the adjoining trees, upon which larvæ were also present. It is necessary, absolutely necessary, if success is to be expected, that the insects, upon their arrival, should be liberated without a moment's loss of time upon the proper scales. In the field during warm weather, if inclosed in boxes without food for three or four days most of the Coccinellidæ would invariably die, even though they were in the best of condition when collected. It will be plainly seen that insects inclosed in boxes for from four to five weeks, even if kept in a dormant state during this time, through the low temperature on ice, will, on arrival here, be in a very feeble condition, and exposure to the dry heat on the way to Los Angeles must be fatal to the largest number of them if not sent on ice, especially so should they be kept in confinement in Los Angeles for a few days before liberating, or if, as has been the case, the insects should remain inclosed in glass jars without proper food. I have always insisted that the beetles should be liberated upon such coccids as were indicated on the boxes within which they were inclosed, and I am positive that if but a single gravid female should thus come into an orchard, even if in an almost dying condition, the open air and the proper food, which they are best able to select, would soon bring her back to health, and that she alone would be able to produce sufficient offspring to make the success of future propagation of the species certain. No gravid female Coccinella will leave a tree that supplies sufficient and proper food for the coming generation, but will remain and deposit all of her eggs upon this one tree in due course of time, and if not disturbed in any way the success of the species is assured. I will go still

further in claiming that, if a couple of dozen of gravid females of one species of coccid-feeding ladybirds, such as *Orcus* and *Rhizobius*, were liberated in San Francisco upon arrival of steamer, some of these would find the proper scales upon which to breed, even if from 10 to 15 miles distant, as these insects are able to go without food for days in the open air, simply sustaining life upon dew or any other moisture, Aphidæ, or larvæ of other insects, as is the case with *Orcus australasia* Boisd., which will feed upon almost anything, and even breed upon Aphidæ and leaf-hoppers. The country is full of all such insects at every few yards, and in many places some kind of scales are found upon which they can feed, even if but upon the young of same. Even the *Coccinella* proper, which usually breed upon aphids, are not entirely confined to this food. *C. antipotum* White, no doubt breeding upon Aphis, has been observed in large numbers breeding upon a large coccid on my former visit in New Zealand, hundreds of their larvæ being present and feeding upon *Ctenochiton viridis* Mask. On this last trip *Coccinella arcuata* Fabr. was found breeding upon Aphids on orange at Toowoomba, Queensland, while on the Richmond River, New South Wales, the same insects were found breeding upon *Lecanium filicium* Boisd., and again at Levuca, Fiji, they were breeding upon a species of *Aleurodes*, infesting the taro leaves, upon which also another and much larger coccinellid was feeding, that had been found breeding upon a *Dactylopius* at Nausori, Vitu Levu. These and many other instances may be mentioned, showing that none of these valuable insects are confined to one particular food. By studying the habits of such individual species below, the reader will come to the same conclusion. In no instance did I meet with *Orcus chalybeus* Boisd. feeding in the larva state upon *Lecanium* in Australia, and yet this beetle is breeding successfully upon *L. oleæ* Bern., at Santa Barbara, Cal.

All insects found preying upon Aphidæ and scale insects of whatever species they were had been closely studied in the field, and of most of these the whole life history had become known, as all the unknown larvæ found were bred to maturity. This course prevented the introduction of any during the earlier stages here, thereby introducing the parasites preying upon them, in which case their work upon our coccids would have been by no means so effectual; moreover, this parasite would not only have destroyed the larvæ of the introduced species but those of our own species as well, which at the present time seem to be free of such, although Mr. Hubbard, in "Insects Affecting the Orange" (p. 74), figures one of these parasites, *Homalotylus obscurus* How., which he bred from a *Hypodamia* larva in Florida. Only in one instance where at the time an apparently new *Orcus*, *O. nummularis* Boisd., was found in a locality not easily reached, all larvæ, pupæ, and beetles obtainable were forwarded to Mr. Coquillett, with the special request that the box be opened in a closed room, as these larvæ contain parasites destructive to this as well as all our own coccinellid larvæ, and that this insect be

bred in confinement only. These particular parasites were bred from the most of the larger coccinellid larvæ, yet were found most numerous upon *Orcus*. During my last visit to Toowoomba, Queensland (April 6-11, 1892), the deadly work of the *Homalotylus* was plainly illustrated. In one orange orchard most of the leaves had dropped off from the upper parts of many trees, as also a large part of the fruit, from the effects of the Red Scale, which is always most numerous during the driest and hottest part of the year (March and April).^{*} It was hard work here to gather a couple of dozen of *Orcus chalybeus* Boid., and *O. australasia* Boisd., within five hours, yet the dead and parasitized larvæ were present by the hundreds. Something similar was noticed near Sydney upon a couple of young orange trees that appeared to be in a dying condition; yet a few weeks' work of the predaceous insects upon the scales and a shower of rain brought the trees again into the best condition, with no apparent Red Scale whatever. It is during the hot and dry weather in Australia that the Red Scale becomes most prevalent and the insects preying upon it rarest. Moisture appears to be more favorable to the development of the Coccinellidæ and unfavorable to their enemies, as it also is to the copious growth of the fungoids destructive to Coccidæ. It has been estimated that about 50 per cent of the larvæ of the first brood of *Orcus* were destroyed by the parasites alone, and, as in the case just mentioned at Toowoomba, nearly the entire lot of the second brood were killed; yet this must be subject to variation.

The more prominent enemies to the *Orcus* are the various birds which feed on the larvæ as well as on the mature insects; numerous small lizards that inhabit the trees and, what are considered otherwise beneficial insects, numerous mantis eat their larvæ with avidity. Repeatedly these have been observed to completely devour a full-grown larva in less than one minute, and since they have such well-known and continuous appetites, they must devour large numbers daily.

Probably these parasites (yet another species) upon *Rhizobius* are still more numerous. Hundreds of parasitized larvæ of *R. ventralis* Muls. were found at Melbourne, under the bark of *Eucalyptus* that was infested with *Eriococcus eucalypti* Mask., while the healthy insects were but few in numbers; here at least, and with the other forms as well likely, nature has come to help in providing a secondary parasite that preys upon the *Homalotylus* larva. The same condition of things exists in the closely-related species, *R. debilis* Black., that preys upon the Black Scale on the olive at Adelaide. In addition to the parasites destroying its larva, a second species was found destroying most of the

^{*} This orchard is situated near the top of a very steep hill exposed to strong winds. The soil is a heavy red clay, and the rain would wash down most of the top soil without giving sufficient moisture to the roots below. The unsuitable condition more than the scales may be the cause of the trees losing part of their leaves and fruit.

pupæ. Of one of the smallest coccinellids found in Australia, *Scymnus flavifrons* Blackb., that preys chiefly upon various black scales, the larvæ as well as the pupæ are destroyed in large numbers by small parasites. It is doubtful whether there exist any Coccinellidæ in Australia that are not preyed upon by parasites in one form or another; the larvæ of *Norius* and perhaps *Chryptolemus*, which was bred in large numbers without obtaining parasites, may be exceptions.

It goes without saying that if such insects are introduced into any new country without their natural enemies and the parasites that have hitherto preyed upon them and retarded their increase, they must become most prolific in their propagations.

About 40,000 specimens of various coccinellids were collected on this trip and forwarded to California. I give a brief account of such species as had been named for me. With the rest, which consist chiefly of various species of Rhizobii and Scymnids, nothing can be done at present; they were returned to Rev. Mr. Blackburn for determination.

Parasites of the so-called Australian locust were also bred from this, and as these were rather scarce, but a small number (92 pupariæ and 2 larvæ, representing three species of flies) could be obtained, which were forwarded to the Entomologist at Washington, who reported that they arrived in poor condition, as a number of them had hatched between San Francisco and Washington. These insects arrived here in January. Internal parasites of *Lecanium oleæ* Bern., and *L. hesperidum* Linn. were sent here, and two species of an internal parasite of *Aspidiotus nerii* Comst. were liberated together with internal parasites of *Lecanium depressum* Targioni—this latter upon *L. hesperidum*.

The larvæ of three moths that are remarkable in cleaning whole trees of scales were sent over; those of two species of *Thalpochares*, feeding upon all larger coccids, and of a tineid, that often covers whole trunks of orange and lemon trees with a fine silky web, under which live hundreds of larvæ that devour the scales. Two species of fungoids that are destructive to the black and red scales, *Chionaspis citri* Comst., and *Mytilaspis gloveri* Pack., were sent here. An attempt will be made to establish them upon those coccids in California.

The most if not all the insects liberated here as directed will, in my opinion, breed successfully. The more valuable species naturally will make themselves known first upon our fruit trees, while others may not be seen again for years, feeding upon such scales as infest trees in the forest.

I expect the best results of the various Rhizobiids which will feed upon most of our Coccidæ, having numerous broods annually and whose larvæ are to be found at any time during the year. Some twenty species of these were sent here.

The four species of *Oreus* sent to Mr. Coquillett, if my observation in the field is correct, have but two broods annually, the mature insects

hibernating during the winter months. Their larvæ will feed upon various scales.

A number of other species and of several genera of coccid-feeding ladybirds were sent, as also all those met with which prey upon the Aphidæ.

While this attempt at introducing coccid-feeding insects will without doubt result in time in much benefit to America, as the species if once numerous can be sent to other parts, we should not leave off here, since the work in the future will be much easier. We have learned that insects collected in the autumn can be sent on ice with safety to any desired distance, and we have also learned the food habits of a great many species in Australasia. We could easily get hundreds of coccid-feeding insects into America with comparatively little expense, not only to free our fruit trees from the present scale pests, but to be prepared for any new coccid that may be introduced in the future. Great care must necessarily be taken not to introduce any of the parasites which prey upon these beneficial insects, as this would considerably reduce the good already accomplished. We would never rid ourselves of the parasites destroying our friends, and it would again become necessary to hunt up other agents to destroy our scales and those insects preying upon the destructive parasites, which could not be so readily done.

Syrphid and *Chrysopa* larvæ were met with in large numbers everywhere in my travels. We know the value of these insects, and yet I did not deem it wise to send any of them over to America, since the parasites preying upon them are as numerous as upon our own species, and they are many. The result of such an attempt would be that those insects here, notwithstanding the additional species introduced, would be attacked by about twice the number of parasites and naturally would become of much less value in destroying our pests. Such an attempt can only be made with the certainty that the parasites thus introduced shall not be allowed to see the open air, while on the other hand proper opportunity to breed is given the surviving flies, and this requires the closest personal care of an entomologist having his profession at heart and inspired by an earnest enthusiasm.

Under the existing condition in California fruit trees have to be sprayed or fumigated annually, at a cost, as I have been informed from various sources, of from 50 cents to \$1 for each tree. Naturally this is a continuous loss to the owner, as the operation has to be repeated every year and without any hope of securing permanent immunity. One prominent gentleman in Los Angeles recently informed me that "his orange crop amounts to \$2,000, and the fumigation of the trees to \$3,000."

On the other hand, we all know what good our beneficial coccinellids, *Chilocorus bivulnerus* Muls. and *Scymnus marginicollis* Mann., are able to accomplish if left undisturbed, *i. e.*, not destroyed by chemical applications; and it must seem plain to every thinking individual that a few

dozen of such species—and the world possesses hundreds of them—naturally must in time keep in check the scales destructive to fruit and other trees, so as to effectually prevent injury. We can solve this simple matter by introducing all insects preying upon coccids as well as upon other injurious insects, and protecting the same by discontinuing the process of spraying and fumigating, which, if continued as at present, will have to be done until eternity.

NOTES ON THE ENEMIES OF SCALE INSECTS IN CERTAIN COUNTRIES.

HAWAII.

In accordance with my commission from you, and letter of instruction from the Entomologist, I left San Francisco for Honolulu with a lot of beneficial insects on August 11, 1891, to spend a few days at this place and to look into the general condition of scale insects and their enemies.

The most injurious coccids at these islands are the various species of *Dactylopius*, which are not only injurious to most plants and trees, but are a great plague to the coffee industry, actually destroying whole fields of these trees. *Pulvinaria psidii* Mask. is another very prevalent coccid infesting a great many shrubs and trees. The guava and coffee trees were always found covered with this scale. *Lecanium acuminatum* Sign., *L. depressum* Sign., and *L. longulum* Douglas are also found in large numbers. The condition of the coffee industry has, according to recent accounts, become somewhat more favorable, and natural enemies have probably turned up to feed upon these scales. Yet from what was seen at Honolulu it may positively be stated that no proper and effective enemy has as yet begun to prey upon these particular coccids.

I would recommend as the most effective and easily introduced enemy of these scales the *Cryptolemus montrouzieri* Muls., of which the particulars are given below. Within a few years these beetles and their larvæ would become so numerous that practically the mealy bugs would be reduced to small numbers. In addition a number of other and also effective enemies could be introduced to the great benefit of coffee-growing. The *Cryptolemus* beetle would at the same time also feed upon the various species of *Pulvinaria* and *Lecanium*, and here the various species of *Rhizobius* would do good work. A number of our *Chilocorus bivulnerus* Muls. were given to Mr. A. Yaeger, who turned them loose in good condition.

Internal parasites are present upon the Lecanidæ, and one of these preying upon *L. depressum* Sign. has been brought to California in considerable numbers and liberated in an orange orchard infested with *L. oleæ* Bern. and *L. hesperidum* Linn. A few species of Scymnids were found upon these scales and *Coccinella abdominalis* Say. had been found, especially upon *L. depressum* Douglas, with numerous eggs, larvæ, and imagoes; these and three species of Scymnids were sent to California.

On September 10, 1891, I reached Auckland, New Zealand, and four weeks were spent here in search of predaceous insects. Here some three hundred coccinellids brought from California were turned loose on apple trees full of Woolly Aphis (*Schizoneura lanigera* Hansm.). The species were *Hippodamia convergens*, *Coccinella californica*, and a few *C. sanguinea*. Some three hundred *Chilocorus birulnerus* were found dead in the box, while of the other only five dead insects were found in the boxes. Two species of *Chrysopa* found feeding on Woolly Aphis in California were also left here, these were in pupa state; and some larvæ of *Raphidia*.

On my former and well-known hunting ground at Drury, near Auckland, various species of Scymnids were found breeding upon various *Ctenochiton*; many of these were collected, and *S. acceptus* Brown, *S. consors* Brown, *S. villosus* Brown, *S. flavihirtus* Brown, *S. fagus* Brown, and *S. picinus* Brown were forwarded to Mr. Coquillett. The last-named species has a close resemblance to *Rhizobius satellus* Blackb., the most numerous insects preying upon the Red Scale in Australia. A search was made for *Leis antipedum* Muls., which had been found on my former visit in such large numbers breeding upon *Ctenochiton viridis* Mask., but the insect had apparently not left its winter quarters and but two specimens were found and sent here. These coccids at the time were all very small, having only recently hatched. Capt. Brown was commissioned to search for this beetle during January, 1892, and he also failed to find any of them.

Our native *Aspidiotus camelliae* Boisd. (*A. rapax* Comst.) is one of the most numerous around Wellington, where it does great damage to various shrubs and trees, having as yet no natural enemies; the introduction of such from here and Australia would soon alleviate its seriousness. Our *Chilocorus birulnerus* Muls. and some of the Scymnids could be imported with advantage; yet much nearer, in Australia, far better enemies to this scale could be found in the various species of *Orcus* and *Rhizobius*, which at the same time would also destroy all other injurious coccids. The fungus *Microcera rectispora* Cooke could likely, in the damp climate of New Zealand, be introduced upon this scale; if so, with this alone it could almost be exterminated. *Lecanium oleæ* Bern. was found quite abundant upon some trees in Dr. J. L. Campbell's olive orchard at Lone Tree Hill, near Auckland. Internal parasites were here at work, but no predaceous insects were found preying upon them. In one of the nurseries, upon a lot of young olive trees, the closely related form *L. cassiniæ* Mask. was found in large numbers with its male form. A small bird, the so-called "white eye," is no doubt preying upon the black scales in New Zealand. I have myself observed a swarm in a large oleander bush at a churchyard in Auckland, and the gardner present told me that those birds frequently visit these

plants to feed upon the scales. An investigation showed but few of the coccids left, yet many white specks were seen where these had been removed. Mr. Tryon also speaks of these birds as feeding upon black scales in Queensland.

The Woolly Aphis is doing extensive injury to apple trees in New Zealand, and it is hardly likely that this pest can be better or more successfully fought than with natural enemies, since all the trees are grafted upon blight-proof stock, and the insect in reality only works above ground. The various ladybirds, syrphid, and *Chrysopa* larvæ, if introduced, could easily keep these trees practically free. I would also advise an attempt to introduce the lepidopterus larva that preys upon a closely related form of aphid upon bamboo in New Caledonia. This could easily be accomplished through the agricultural department of New South Wales, where the insect could be tried first.

Dactylopius aurilatus Mask. was met with in countless numbers upon *Araucaria biduilli* Hooker, in the parks at Auckland, as yet free from any natural enemies. By introducing a few *Cryptolamus montrouzieri* Muls., from Sydney, the trees could be freed of this in a very short time and the beetles would also become great benefactors in feeding upon most of the Lecanidinæ and Coccidinæ, with which New Zealand is well supplied. Indeed this is one of the most valuable insects that could be had for New Zealand. *Thalpochares cocciphaga* Meyr. should also be introduced for the various large coccids.

On October 9, 1891, the first lot of insects were sent to Mr. Coquillett from New Zealand. On the same day I left for Australia and here the best field for predaceous insects was found. The amount of new material found during my seven months' work, chiefly in New South Wales, will show that a great deal of work is yet to be done in Australia in the way of studying the beneficial insects. Very little of this is as yet known in the northern and western part of the continent.

AUSTRALIA.

If once thoroughly known the number of Coccidæ and their enemies in Australia will be something astonishing, and it will be found that this country is the original home of many species that have spread over the greater part of the globe.

As regards the Lecanidæ, I am of the opinion that *L. oleæ* Bern. originated in Australia, since I have never been able to find any tree or shrub infested with this that did not show some male scales or traces of such. It is true that the form *L. cassiniæ* Mask., in which I could never find any difference from *L. oleæ*, and which, according to Mr. Maskell himself, "may yet prove to be a small variety of *L. oleæ*," is always the most numerous. Everywhere throughout the country this was met with upon very many shrubs and trees. I have seen forms upon orange and lemon trees fully as large as any *oleæ* and hardly different in color. And is it not very strange that *L. cassiniæ* should be found alone upon

olive trees in South Australia, and that all the oleander in Australia and New Caledonia should be attacked by this form only? In investigating this matter it should be understood that the males of *Lecanium* are only found during a short time. In California, where I have had a better opportunity to look this matter up, the males of a number of native species bred are found in the early spring. From the end of February to the middle of March the long, narrow, carinated male scales are visible in numbers chiefly upon the leaves of plants and trees infested with these coccids. It is during this latter month that the males make their appearance and copulate with the young females, probably in the second stage. After this the empty male scales will soon drop off and all traces of them are lost, while the females go on with their usual growth, becoming full grown only a few months later. May it not be possible that if some of these newly hatched female *Lecaniums* should be landed in a new country without any male forms they would go on breeding and producing a slightly different form from the original without any males? I am almost positive this will be the case. The question is an interesting one and if pursued may lead to many facts establishing the origin of the species. In my opinion, most if not all the *Lecanium* have a male form in their native home.*

The scale infesting the orange, lemon, and many other trees and shrubs, which I take to be and which Mr. Maskell said "may probably be" *Lecanium hesperidum* Linn., was never found without the male form in Australia. *Lecanium filicum* Sign., according to Mr. Maskell, was found by Signoret and Douglas upon exotic ferns. It was met with in large numbers infesting a fern (*Lomaria* sp.) on the Richmond River, New South Wales. This coccid is closely related to *L. hemisphaericum* Targioni, but a little smaller. The species will also prove to have a male form in Australia if looked for at the proper time. It is also likely that *L. hemisphaericum* Sign. is nothing more than a derivational form of *L. filicum* Sign. I have recently seen at Alameda *Lecanium tessalatum* Sign. infesting an Australian fern, and with it many male scales of same.

Parasites observed preying upon *L. hesperidum* Linn., and one species preying both upon *L. oleae* Bernard and *L. cassinae* Mask., were repeatedly sent to California. Specimens were forwarded to the Entomologist for identification.

The predaceous insects upon the black scale are very many in Australia. Three species of *Orcus* were found preying upon this scale, and the fourth, the largest of all, *O. bilunulatus* Boisd., will, without doubt, feed upon the same in time, if it does not do so already. Numerous species of Rhizobiids, Scymnids, and other allied species feed upon them.

* I have bred males of the following *Lecanium* in California, which will likely prove to be indigenous: *Lecanium* sp. on *Quercus agrifolia*, *Lecanium* sp. on *Pinus insignis*, *Lecanium* sp. on *Heteromeles arbutifolia*, and *Lecanium pruinulosum* Coq. Of this latter I have only had male scales.

Thalpochares cocciphaga Meyr. is nearly always present where these scales occur in large numbers. A fungoid is cleaning whole trees of them and an attempt will be made to introduce the same into California. Probably the same fungoid is destroying *Lecanium depressum* Sign. in Fiji, where whole colonies of these scales succumb to its attacks. A second species of fungus was found in these islands that lives upon the *Lecanium*, these latter becoming black, globular, hard masses. It is also a fungoid that destroys *Leerya* in Fiji.

It is only upon bushes or young trees generally covered with large numbers of ants, which prevent the predaceous insects from coming near, that the black scales become numerous, and even these are entirely freed of them when the fungoid once becomes established. Upon old trees these scales are rarely found in any number, and if so only upon an occasional branch, which is speedily cleaned again by the numerous predaceous insects preying thereon.

But three species of Coccinellidæ were found preying upon the black scales on olive trees at Adelaide, namely, *Rhizobius debilis* Blackb., *R. cævus* Blackb., and a very small insect, *Cyrema nigellum* Blackb. All these are small insects, and if no others help to free these trees from scales, their work is remarkably good considering the numerous parasites preying upon the *Rhizobius* larvæ and pupæ.

Aspidiotus aurantii Mask. is perhaps the most numerous coccid upon citrus trees throughout Australia. Whether the insect is in reality introduced, and if so when, will be difficult to decide. The Hon. Robert E. Scobie, of West Maitland, New South Wales, who is well acquainted with all insects affecting fruit trees, informed me positively that this same insect was very numerous fifty years ago upon his trees. Only in rare instances are holes found from whence minute chalcid parasites have issued, and these in the majority of cases on the male scales. From this very fact I hardly think it to be indigenous. It is a fact that this insect is at present the most injurious to citrus trees in Australia, in instances destroying an occasional limb, or even, in rare cases, a whole tree, where these are neglected (but this I have never observed). Unless the greatest wisdom is shown in dealing with this pest it will become so serious as to make profitable orange-growing impossible. Australia is in possession of more than enough natural enemies to keep this coccid in check with ease. To spray or fumigate to kill the Red Scale would also mean the destruction of the numerous beneficial insects, and those that were not killed outright would mostly leave the orchard in search of other food, and the consequence would be that in a few months the trees would again become infested, with no enemies present, and the scales would do great damage unless the spray were again applied.

As it is at the present time, orange and lemon trees are planted in almost any locality, without regard to the situation, condition of the soil, drainage, climatic, and other conditions. The consequence is that

some of the orchards become diseased, presumably from the effects of the Red Scale, and, as is the case at the Gordon district, near Sydney, one tree after another will succumb. An examination showed that these trees had been planted in heavy, clayey soil, without any drainage, and were invariably destroyed by the so-called "foot rot." The fact is, that if an orange or lemon orchard, as the case may be, is planted in an unsuitable location or soil, left for years without any attention whatever, and the weeds allowed to grow, before very long the leaves will become yellow and drop off slowly, and in time the remaining green leaves will become covered with Red Scale, since, as is always the case, the predaceous insects preying upon them are not found on such trees, as they prefer trees with dense foliage and shade. Such trees may thus linger for months or even years before dying, and may even again recover if proper attention is given them. In one such orchard, of several acres in extent, but a few living twigs covered with Red Scale were found on many of the trees, yet not a single one of the many predaceous insects preying upon them could be noticed. In another instance an orchard of some 8 or 10 acres and about 35 years old, the proprietor of which always supplied sufficient manure and kept the ground cultivated, during the whole of its existence had been infested with red as well as other scales, and yet but a very few trees along the border of one side could be found that showed any traces of them. The whole orchard within the 35 years had never been pruned, sprayed, or even washed. Numerous dead limbs were present, the stems and limbs partly covered with lichens, and yet I have never met with, in Australia, a finer lot of trees, such glossy deep-green foliage, abundance of fruit, and so free from scales at the same time.

A large number of predaceous insects were found preying upon the Red Scale in Australia. Of the most numerous were *Orcus chalybeus* Boisd., *O. australasia* Boisd.; and one of the small *Rhizobius* was always present in extremely large numbers. This is *R. satellus* Blackb. *R. hirtellus* Crotch* is numerous around Sydney, but more so at Toowoomba. *R. Toowoomba* Blackb., *R. debilis* Blackb., *R. cactus* Blackb., *R. plabeius* Blackb., *R. pulcher* Blackb., were all found upon this scale, as also various species of Scymnids, *Midus pygmaeus* Blackb., *Lipernes subviridis* Blackb., were always numerous. *Serangium maculigerum* Blackb. and *S. hirtuosum* Blackb. were also found on trees with this scale, and several more of which I have as yet found no names.

The small tineid larvæ, feeding on *Chionaspis* and *Mytilaspis*, have also been found preying upon this coccid where numerous. A fungus, *Microcera coccophila* Desm., often destroys all these scales upon trees around Sydney, as well as *Chionaspis citri* Comst. and *Mytilaspis gloreri* Pack. An attempt has been made to introduce the same upon the Red Scale in California. Mr. Tryon mentions this fungus and one *Rhizobius*

* The description of *R. hirtellus* does not agree with my insect, which is close to *R. cactus* Blackb.

as natural enemies. The description of his beetle agrees with *R. Toowoomba* Blackb.

Chionaspis citri Comst. becomes numerous occasionally in some of the orange and lemon orchards at Paramatta, New South Wales. This also has its natural enemies in the various predaceous insects. The larvæ of a small tineid moth often covers whole trunks and branches of the trees with a fine silky web interwoven with remains of scales, etc., under which the numerous small caterpillars live and devour all the coccids, the various Coccinellidæ devouring such as are found upon the outer part of branches and leaves.

According to Mr. Tryon, a fungus, *Microcera rectispora* Cooke, is destroying this as well as *Mytilaspis gloveri* Pack. at Toowoomba. I have found *M. coccophila* only upon these coccids at Paramatta. Without doubt the *Orcus* will feed upon these scales, and *Rhizobius* has often been noticed to do so. This scale is also numerous in New Caledonia, where *Rhizobius dorsalis* Blackb., or a very closely allied species, is found preying thereon in numbers. It is also common throughout Vitu Levu, Fiji, where it was met with upon cultivated as well as wild citrus trees in the forests. At this latter place *Anisoreus affinis* Crotch and *A. Fryi* Crotch, which seems to be identical with the first, prey upon it; the little yellowish spiny larvæ, resembling those of the young of *Orcus chalybeus*, are very numerous. A small tineid larva was also found preying upon this coccid in Fiji, where the above fungus could easily be introduced upon the scale.

I have had no opportunity to study the natural enemies of *Aspidiotus camellie* Boisd. and *Mytilaspis pomorum* Bouche, scales found in America and Australia as well, in the latter country, yet it may be safely said that their injury to fruit trees, if not already kept in check, can be overcome with the numerous native coccid-feeding Coccinellidæ and the fungus *Microcera coccophila* and *M. rectispora*, which, upon the *Mytilaspis* at least, could be established.

In my first visit to an orange orchard at Paramatta, on October 23, 1891, and upon the first tree infested with Red Scale examined, numerous eggs, young larvæ, and mature insects of *Orcus chalybeus* Boisd., and *O. australasia* Boisd. were found, as also various species of *Rhizobius* and *R. satellus* Blackb. especially, in large numbers. On November 2, 1891, the first lot of insects left Sydney for Los Angeles. This consisted chiefly of the two species of *Orcus*, which at that time must have laid all their eggs and were still living ever since the previous March and April, as both these species are in a more or less dormant state during the winter months. Besides these, various species of Rhizobiids and Seymniids were sent, as also some ninety specimens of *Scymnodes koebelii* Boisd., an insect preying on *Chionaspis* and *Eriococcus* in Australia, and which may also feed upon the Black Scale and other coccids here. The second consignment to Mr. Coquillet, on November 30, 1891, consisted of about the same material. At this

time the hibernated *Orcus* were still living and no fresh specimens were out yet to send. It was on December 28, 1891, that the first lot of insects left Sydney containing newly hatched *Orcus*, although old specimens were still present. Larvæ of all sizes and pupæ of these were present at the time. The consignment made on January 25, 1892, consisted chiefly, if not entirely, of newly hatched *Orcus*. At this time (midsummer) the insects naturally breed fast and are not long on the wing before laying eggs. It is only after the second brood, from April on, that the *Orcus* do not breed any more and go into hibernation. This could be imported with perfect safety and without having deposited any eggs, as was shown by the lot received by Hon. Ellwood Cooper, where they began to breed in such numbers. Specimens of *O. australasia* brought with me and liberated upon *Aspidiotus perniciosus* Comst., in August, also began to breed at once. On February 3, 1892, I received the first and only letter from Mr. Coquillett, in which he informed me of the poor arrival of the *Orcus* of the first two shipments. Consecutive shipments were thereafter made from different parts of all such predaceous insects as could be found on January 25, 1892; February 22, 1892; March 21, 1892, and April 18, 1892. The last lot was collected in the Blue Mountains and Parramatta, New South Wales, and Toowoomba, Queensland, and consisted of about eight thousand specimens of some fifty species of Coccinellidæ, as also a lot of *Thalpochares* larvæ and pupæ. These were divided into three lots, and one lot was sent to Mr. Coquillett, the second, consisting chiefly of species supposed to feed upon Black Scale, to Hon. Ellwood Cooper, and the other, consisting chiefly of *Orcus*, to the State board, with the request that they be liberated upon the pernicious scale (*Aspidiotus perniciosus* Comst.). As I was informed later, by Mr. Cooper and the State board, nearly every one of these insects arrived in perfect condition, as did also those of the previous sending.

As requested, on December 9, 1891, I proceeded to Hay, New South Wales, in quest of parasites of the Australian plague-locust. Upon arrival at this place hardly any traces of them could be found, and as some were noticed along the road I returned to Whitton, at which place the grasshoppers, although not very numerous, were found in sufficient numbers to obtain the dipterous larvæ parasitic upon the two closely allied species. One of these, the same as met with on my former visit, is *Chortologa australis* Saus., and the second is what Mr. Olliff calls *Pachytylus australis* Br. Ninety-two pupariæ of two species of diptera and two larvæ of a third species were obtained within a week's work, and all living locusts were left in charge of a party, but none of the parasites raised from them ever came into my possession. Those sent to America were directed to the Entomologist in Washington, who reported to me that most of the flies had issued before reaching him, and others should be sent to Mr. Coquillett, who could liberate them where *Coloptenus devastator* was numerous. Unfortunately, at the time this letter

was received no traces of the plague locust were left and a further attempt to secure more of their parasites had to be abandoned. These fly-pupas must have hatched after leaving San Francisco, as up to the time of their arrival there they had been kept on ice. By some mistake they were sent to Los Angeles first, and from there, no doubt, over the southern route to Washington, as they would not have come out over the central route in January.

FILII ISLANDS.

On April 28, 1892, I left Sydney for a trip to the Fiji Islands, and arrived at New Caledonia on May 4. Here a few hours could be spared in search of insects, to which I refer elsewhere. The most interesting thing found here were dipterous parasites upon a large species of grasshopper, *Pachytylus micratoroides* Reich., according to Mr. Bruner, who informed me that it is closely related to the migratory species of Europe, Asia, and Africa. These latter were but sparingly met with in the dry hillsides near Neumea, yet the ground was noticed to be full of dead and empty individuals. In living specimens examined dipterous larvæ were found, and from these two species of flies were bred in course of time. Upon some of the locusts, as well as upon their larvæ and pupæ, dipterous eggs could be found. Upon one of the pupæ eight of these were found upon the hind legs, the wings, and pronotum. The locusts are always more or less numerous upon this island, with its bare hills, and in consequence sugar-growing had to be abandoned, as they devour most of the young cane. About a week previous to my arrival some 8 tons of the locusts were collected in traps, such as are in use in Algiers. I met with large numbers of them along the road some 8 miles from the city, at about 3 p. m. For a half mile in length the road was completely covered with the locusts, which came from the adjoining low and swampy land, which supplied abundance of food, and the air was cloudy with them to a height of some 300 feet. Their flight appeared to be in an easterly direction. No doubt they left their feeding ground to repair to the bare hills to deposit their eggs, or probably, to evade the dipterous parasites which must have been present in countless numbers, as was noticed on the hills near Neumea, where within a space of some 20 square yards some two hundred and fifty *Sarcophaga* were collected within less than one hour's time. The flies were sitting around the plants at rest, or were, as it appeared, in search of the locusts near the ground where these were hidden. With the exception of the numerous dead and a few living locusts no other insects were present upon which these flies could breed, and the occasional Lepidopterous larvæ met with were all in a perfectly healthy condition. I concluded that the countless number of *Tachina* present could only have developed within the grasshoppers, and the numerous dead and eaten out specimens were proof to me that these flies had done the work. I collected these flies with a view to introducing them, if possible, upon

Pachytylus australis Bruner, which, as Mr. Helms, of the Colonial Sugar Company, who was with me, said, were very numerous in the Ba River, Fiji, and at this place often destroyed whole fields of young cane. The attempt was very interesting, and I will relate the circumstances connected with it in full, as they no doubt will lead to an easy way of introducing these beneficial insects so fatal to locusts into other countries, and we may thereby eventually overcome the serious losses that follow the invasions of locust swarms. It is proven that one of these flies may be able to produce upward of 20,000 living maggots, and the development is, as will be shown, astonishingly rapid in a warm climate.

I left Neumea with the living flies in glass jars upon ice, on the evening of May 5, 1892; two days later my flies began to die slowly, and upon arrival at Sura, Fiji, May 9, 1892, but very few were living, yet the jars were full of living maggots which were feeding somewhat upon the dead flies. It was only four days later, May 9, 1892, at Nausori, that I had an opportunity of getting a lot of *Pachytylus australis* Bruner, and by this time the remaining larvæ had made a little growth, some measuring about one-fourth of an inch in length. I made a small opening in the tender skin of the locusts between the head and pronotum, and in this one or two of the maggots, according to size of locusts, were placed, which disappeared almost immediately in the interior. Others were also placed under the slightly raised pronotum, where they remained and buried themselves alone in the body. Four days later I examined the jars containing the locusts with sod and, to my surprise, two puparias of the fly were already present, while on the following day (May 14, 1892) over one hundred of the puparias were found, showing that these larvæ will attain their growth in from five to six days. I buried the puparias about half an inch in the soil, and on examining a few days later found that a colony of ants had established their home with and were destroying these. Some five or six of the puparias were already eaten out. All were taken up and again buried separately in various places. These, as was found later, were not again molested, but produced the flies in from eleven to thirteen days. This will show that the whole transformation of these flies will not take more than about eighteen days, and, supposing that only a few hundred of the maggots of each fly would come to maturity, it would be but a short time before a large number of the locusts would be annihilated within an area of a few miles, and by distributing the *Sarcophaga* over the infested portion of the country, the locusts could no doubt be destroyed within less than three months.

Hundreds of various grasshoppers were examined in Fiji in the hope of finding internal parasites, yet not in a single case could I find any, nor could any dead insects be found indicating the presence of a parasite to destroy the locusts, other than such as were destroyed by fungoids.

During my stay at and while crossing Vitu Levu, Fiji, insects were anything but numerous outside of the locusts. The fungoids in the damp climate here appear to be the principal agents in destroying the insects, especially the Coccidæ, most of which are affected. I also noticed a small hemipterous insect infesting pea vines, which was destroyed in large numbers by one of the fungi. As already mentioned, our coccids *Chionaspis citri* Comst. and *Icerya purchasi* Mask. were the only ones met with in large numbers throughout the island of Vitu Levu, as well as at Levuca.

The most injurious insect upon these islands is unquestionably *Sphenophorus obscurus* Boisd., introduced on sugar cane some ten years since from the Sandwich Islands, and at the present time infesting nearly all the cane fields. At Nausori Mills, so Mr. Seeliger informed me, 52 per cent of the entire cane from some fields is infested with the *Sphenophorus* larvæ, and if we consider that in some instances half of the cane is destroyed by this beetle before reaching maturity, the extent of the injury done can be estimated. They also attack the banana plants, their injury to which has also become a serious matter. No parasites are yet preying upon these larvæ and, unless some are introduced to check the ravages of the beetle, cane-growing will be almost an impossibility in the near future. So numerous is the insect already that within one day along the border of the fields at Nausori, under pieces of split cane laid out for bait, 11 children collected no less than 28,800 of the beetles. I have advised the introduction of our toads, both in the Sandwich and Fiji Islands, which, with the unlimited amount of food, would rapidly increase and eat up these beetles in large numbers, providing the mungos will not interfere with them. A moth closely related to the common sugar-cane borer, *Diatraa saccharalis* Fabr., is doing some damage also, but little in comparison with the *Sphenophorus*.

On June 30, 1892, I returned to Sydney with little save a number of the *Anisoreus* found preying upon *Chionaspis citri* Comst. at Fiji, and two species of fungoids destructive to Black Scale. The beetles, their larvæ and pupæ, had been kept on ice during the trip and but very few of the mature insects were dead on arrival at Sydney. These were fed until the steamer left for California, when they were again placed on ice, but none of these reached San Francisco alive.

My future movements depended upon the last two sendings from Australia. In letters received from the State board and Hon. Ellwood Cooper, which awaited me at Sydney, I was informed that these arrived in perfectly healthy condition. I was now sure that the species liberated here would successfully breed in their new home.

Another lot of *Orcus chalybeus* Boisd. and *O. australasia* Boisd., which at this time, July 3, 1892, were chiefly hibernating, was collected. Of the various Rhizobiids and Seymniids a number were also collected. *Thalpochares cocciphaga* Meyd. were also hibernating, and some one

hundred and fifty larvæ of various sizes were collected. They were at this time all spun up and to all appearances feeding but little. Two days were spent in getting a lot of *Scymnodes Koebelei* Blackb., an insect preying upon *Chionaspis* in Australia. This may also feed here upon the Black Scale.

With these I left Sydney on July 11, 1892, and all insects brought to San Francisco, where I arrived August 5, 1892, were, with the exception of those from Fiji, in a very healthy condition and were liberated upon the proper scale insects.

The *Thalpochares*, not having been kept on ice, began to issue at sea, July 24, and during the night of July 29, the ants killed a half dozen. Fresh food was given at Honolulu, but no eggs were found in the jar when liberated at Haywards, Cal., August 6, 1892.

DESCRIPTION OF SPECIES.

I will now give a general account of each species separately, at the same time stating upon what coccids the insects were found feeding and upon which of our scales they may be expected to feed, as also such other notes as may be of interest.

INSECTS FEEDING ON COCCIDS.

Coccinella arcuata Fabr.—This will probably prove one of the most beneficial of all the species in this group met with, as its habits are so various. I first met this insect in numbers, and in all stages, on January 10, 1892, on the Richmond River, New South Wales, feeding upon *Lecanium filicium* Boisd., on a fern, *Lomaria* sp., which was growing in a damp place in the woods. Quite a number of these were forwarded to Mr. Coquillett. Again, on April 6-11, 1892, the insect in all stages was found at Toowoomba, Queensland, in a few specimens only, feeding upon orange aphids. These last specimens, if I remember right, were sent to Hon. Ellwood Cooper, who liberated the same on arrival. On June 19, 1892, the very same insect was found quite numerous at Levuca, Fiji, feeding in all stages upon a species of *Aleurodes*, infesting the taro leaves (*Colocasia* sp.). Mr. Crotch in "Revision of Coccinellidae," gives the following localities of the species: China, Philippines, Singapore, Java, Cape York, New Caledonia, and (doubtful) Cape of Good Hope. The insect would prove valuable with us in feeding upon all the Aphidea, Black Scale, in earlier stages no doubt, *Aleurodes*, and very likely Psyllidae and leaf-hoppers as well.

Coccinella conformis Boisd.—A very common insect in Australia, where it feeds upon all the various *Aphideæ*, and it may become valuable with us in some localities, especially the drier parts, in the destruction of the Woolly Aphis (*Schizoneura lanigera* Hausmann), as well as in feeding upon the earlier stages of the black scales. The observations made upon this insect on this as well as on the former trip to Australia lead me to this conclusion. I have seen numerous apple trees at Adelaide entirely cleaned of the Woolly Aphis, and so thorough is their work that no trace of the Aphis is left. Mr. Tepper also informed me at the time that when these insects begin their work upon the Woolly Aphis they never rest until every single one is devoured. I have seen a large apple orchard near Castleman, Victoria, on my former trip, which had been badly infested and about half of the orchard from one side where these insects had been at work was entirely cleaned by them. The recent observations in New South Wales and Queensland, however, speak not so favorably for these insects as such an effective enemy to the *Schizoneura*; it was found in both places

feeding upon the *Aphis*, but not in such numbers as to entirely free the trees of the same. The reason of this no doubt is that both in South Australia and Victoria everything becomes completely dry during the summer months and other aphids are but sparingly found, while in New South Wales and Queensland Aphidæ are met with in greater or less numbers all summer, and no doubt this beetle will feed in preference upon these. We may confidently expect good results from this beetle in California at least, as an effective enemy to the Woolly *Aphis*. A number of these beetles, it is said, were liberated at Los Angeles and others were sent to the Hon. Ellwood Cooper, who, as he reported, received and liberated them in fine condition. This insect was numerous the year round at Parramatta, New South Wales, upon orange and apple trees, as well as upon numerous other plants. It was here, and the only instance in Australia, that one of these insects was found dead upon an *Acacia* tree and attached to a yellowish silken Hymenopterous cocoon, such as are often met with both in Europe and America.* On March 28, 1892, on Mount Victoria, New South Wales, the insect was found in all stages upon *Leptospermum* infested with *Eriococcus leptospermi* Mask., and as nearly all the insects found feeding on this scale could be traced to feed on *Lecanium*, this also may be expected to do so.

Coccinella antipodum White.—This insect was found on my first trip in such large numbers at New Zealand, feeding in all stages upon *Ctenochiton viridis* Mask., a coccid closely related to *Lecanium*, and it may no doubt also feed upon this if introduced. During my search for the same in October, 1891, but two specimens could be found; they had at the time apparently not yet left their winter quarters. These were sent to Mr. Coquillett. Capt. Brown, whom I requested to collect this beetle for me during January and February, 1882, also failed to get any of them.

Coccinella abdominalis Say.—This was found at Honolulu breeding upon various *Lecanium*, most numerous upon *L. Longulum* Douglas. It seems to be identical with this species. A number were sent to California, where they were liberated upon *Lecanium hesperidum* Linn., in San Mateo County. Three species of small Scymnids, also found at Honolulu, were amongst this sending. I did not reserve any specimens of same.

Coccinella kingi MacLeay.—This insect was found at Parramatta, New South Wales, upon orange infested with *Aphis*; at Toowoomba, Queensland, also on orange, but most numerous upon *Acacia* badly infested with Psyllidæ, as well as leaf-hoppers, Aphids and a species of *Aspidiotus*, probably feeding upon the first. Larvæ in confinement would not feed upon *Aphis* on oleander. Many specimens were sent to California.

Coccinella repanda Thunb.—A very common insect in Australia and was also met with in New Caledonia and Fiji Islands. According to Crotch, it occurs in China, India, Java, Bali, Flores, Singapore, Triton Bay, Australia, and Tasmania. The larvæ and mature insects were found feeding upon various plant lice, and also upon the Woolly *Aphis* at Toowoomba, Queensland. Was sent in nearly every consignment in numbers.

Neda testudinari Muls.—Another *Aphis* feeding Coccinellid. Was found in numbers at West Maitland, New South Wales, November 5, 1891, feeding upon the peach aphid. Was numerous upon a species of *Ficus* at Brisbane, Queensland, November 12, 1891; at Toowoomba, Queensland, November 15, 1892, upon nettle and myrtle trees. Its larvæ were found feeding upon oranges infested with *Aphis*, at Parramatta, and also at Harwood, New South Wales, January 1, 1892, upon an *Ipomæa*. This insect was repeatedly sent to California.

Halzia galbula Muls.—Found first on my former visit to Australia, at Gordon, New South Wales, upon apple trees, and also at Toowoomba, Queensland, chiefly upon apple trees. On November 13, 1891, an apple tree at this latter place was full of

* Prof. Riley, in "Insect Life," vol. 1, No. 4, pp. 101-105, describes one of these insects reared in America as *Centistes americana*. This, or an allied species, appears to attack many of our American Coccinellidæ.

these beetles as well as their eggs, larvæ, and pupæ. Many of the eggs were, as those of the *Orcus*, fastened onto the spider webs on trunks and branches, but the larger number were deposited on the underside of young and partly closed leaves affected by a fungoid. The entire tree from top to bottom was carefully examined to ascertain the food habits of this insect. With the exception of a few remains of *Thrips* among the affected leaves, not a trace of insect life could be found, and there is no doubt that this insect lives upon the *Oidium*, as do our *Psyllobora*. The beetle was also met with upon orange infested with *Aphis* at Parramatta, at the Clarence, Richmond, and Tweed rivers, New South Wales, as well as at Toowoomba upon various other plants. Many specimens were sent to California.

Halysia pascoei Crotch.—This beetle was but rarely met with upon orange at Parramatta, New South Wales, and feeding upon Aphids. A newly hatched specimen was found on a branch with plant lice. This was not found in sufficient numbers to send to California.

Halysia edwardsi Muls.—A closely related species to the foregoing. Only met with upon orange and preying upon *Aphis*, between the Richmond and Tweed rivers, New South Wales. The insect was not sent to California.

Verania frenata Er.—This was the most numerous insect met with in the Toowoomba district during November, 1891, and could then have been collected by the thousands upon orange and *Acacia*, and yet on a later visit, April 6–11, 1892, when other Coccinellidæ were still numerous, not a single specimen of this species could be seen. They were found besides upon the trees mentioned, upon the Cabbage *Aphis*, where its larva was found, as well as upon apple trees, here feeding on the Woolly *Aphis*. The insect is common in New South Wales and very numerous in Queensland. It seems to be confined to Aphids only. It was also met with in New Caledonia. Large numbers were sent to California.

Verania lincolna Fabr.—This insect was found along the coast from the Clarence River to north of Brisbane, always upon *Aphis*. Very numerous in a cornfield on the Richmond River, and here feeding upon the Aphids infesting these plants. The larvæ were here remarkably numerous, and one of these nearly grown was observed feeding upon a nearly grown larva of *Heliothis armigera* Hübn., that had been in the act of issuing from one of the cobs in a rather narrow hole. The coccinellid larva had eaten a hole into that of the *Heliothis*, which was helplessly struggling and unable to free itself. The insect was also found very numerous in the Fiji Islands, also feeding upon Aphids on wild pea vines, sugar cane, and various other plants. The *Orcus* are closely related to our *Chilochorus*, and their habits are the same. They may be expected to feed upon various coccids with us, and have about two annual broods.

Orcus chalybeus Boisd.—The most effective enemy of the Red Scale met with in Australia. The insect is always found upon citrus trees infested with this coccid and often in very large numbers. As many as three hundred were collected clustered around the base of the trunk of an orange tree at Parramatta, New South Wales, on a day when the temperature reached above 100° F. It is only on such occasions that the beetles will come down near the ground to seek a cool place during the hottest part of the day, and by 5 o'clock in the evening all have again returned among the branches and leaves, upon the surface of which they delight in sunning themselves when not busily engaged in turning up the scales and feeding upon the insects below. Some three thousand specimens were thus collected within about two hours' time. It appears that this insect has but two generations, although beetles can be found during every day in the year. The eggs are deposited by hibernated insects in early spring all over the trunks, limbs, and leaves of trees; spider webs seem always to be preferred to fasten the eggs thereon. Often on single long threads rows of eggs can be seen. No doubt this is done to protect them from the many enemies which feed thereon, its own larvæ, without any question, devouring the most. About the end of December, near Sydney, the bulk of the first brood of

mature insects are out, and the second brood appears in March. But few pupæ were found on March 18, and stray larvæ of all sizes, showing that there are irregularities in the number of broods. Most beetles were found hibernating at the beginning of July at Parramatta, sitting in clusters between folded leaves, etc., and only part of them were active and feeding. No larvæ were observed at this time. This insect was met with in large numbers from Sydney north to Brisbane, upon citrus and other trees infested with Red Scale. It was also found breeding, and likely upon its original food (before the introduction of the Red Scale) upon various species of *Eugenia* (myrtle) that were infested with a species of *Eriococcus*—very near to *E. pallidus* Mask., *Planchonina stylobata* Mask., *Chionaspis eugenia* Mask., and *Fiorinia* sp. at New South Wales and Queensland. The larvæ and mature insects were repeatedly observed feeding upon the *Eriococcus* in New South Wales, and the mature beetle was also seen feeding upon an *Chionaspis*, apparently *Ch. eugenia* Mask., on a *Dracanea* at Toowoomba, and was also found upon *Cycarcia laurifolia*, upon which *Chionaspis eugenia* was present. Naturally, regarding an imported insect such as this, no pains were spared in tracing up all the coccids it fed on in Australia and upon which it would likely feed in California.

This is the only insect of the introduced species seen at Los Angeles on my visit at the beginning of September, 1892. In places where they had first been turned loose they were found quite numerous already in all stages. It is hard to estimate the numbers present, but we will give a low figure, say, 5,000. These would naturally increase about a hundredfold with every new brood, and some 20,000,000 of the beetles could be expected under favorable circumstances at the end of next year, provided they are not destroyed with sprays and fumigation. And if the insect should only increase fiftyfold, and increase they must according to natural laws, the number would amount to some 3,125,000,000 at the end of two years hence.

With this, *Orcus australasia* Boisd. and *Rhizobius satellus* Blackb., as principal agents, I am confident that the now so feared Red Scale will become comparatively harmless within a few years.

Not in one instance did I meet with the larva of this insect upon the Black Scale in Australia, and yet the beetles had increased in large numbers upon this scale with Hon. Ellwood Cooper. The beetle was liberated at my suggestion, upon the pernicious scale in northern California, but up to date, as far as I know, they have not been found feeding upon the same. I look for the insects to appear upon some Chionaspid or Lecaninum scale, and do not believe that they all perished.

NATURAL ENEMIES.

Howalotylus sp.—Large numbers of the larvæ are destroyed in Australia by an internal parasite. Mantis feed largely upon the larvæ, as also do birds, and these attack the mature insects as well. Numerous lizards feed upon the same, and spiders also destroy many. With us the principal enemy, the *Howalotylus*, is not to be feared, and the birds, I am sorry to say, are becoming less every year. Mantis are too rare in California to do any great harm upon these beetles, and spiders do not destroy many. With these favorable circumstances we can expect a rapid increase of the beetle, and it will be some time before the insect is attacked to any extent by natural enemies, as is the case with any newly-introduced pest.

Orcus australasia Boisd.—Probably more valuable than the foregoing (*O. chalybeus*) from its habits of feeding upon so many and various coccids. The Red Scale may be mentioned as one of its most important foods in this country. The larvæ, as well as the mature insects, were nearly as numerous during March around Sydney as its ally. The habits are about the same, and the coccids upon which the insect was found feeding beside the Red Scale were various species of *Lecanium* in South Australia, Victoria, New South Wales, and Queensland; upon *Eriococcus leptospermi* Mask., on *Leptospermum lauratum* at Parramatta, New South Wales, December 21, 1891; quite numerous at Mulgoa, New South Wales, in all stages upon *Acacia* infes-

ted with a species of leaf-hopper (*Tettigonia* sp.). A careful examination of the tree did not reveal any other insect, with the exception of an occasional *Aphis*, upon which the larvæ were also observed to feed on orange. Mr. Tepper, of Adelaide, informed me that he had observed these insects feeding upon leaf-hoppers at Kangaroo Island, where the beetles are very numerous. Mr. Olliff, in "Agricultural Gazette of New South Wales," vol. 2, p. 65, mentions the green aphid of the apple (*Aphis mali*) and the Red Scale, upon which the full-grown larvæ feed. Mr. Tryon was the first who reported this and other *Oreus* as being voracious feeders upon scale insects. No doubt the larvæ will also feed upon *Mytilaspis Gloveri* Pack. and *Chionaspis citri* Comst., infesting the citrus trees in Australia. The beetle with us may be expected to feed upon most of the scales, and, as it is the largest species introduced, the work that the larvæ are able to accomplish when once numerous will be astonishing.

On my recent southern trip the insect was found numerous upon the Black Scale at Mr. Cooper's place, near Santa Barbara, and it is also doing well with me upon prune trees infested with *Aspidiotus perniciosus* Comst. A few specimens were placed upon these trees on May 14, 1892, by Mr. Alexander Craw. I liberated a number of these beetles at Haywards, Alameda County, during August. These were collected at Parramatta, beginning of July, all hibernating together in two batches in an out-house under roof. Out of about one hundred and fifty specimens but four had died when liberated. The insect is preyed upon in Australia by the same natural enemies mentioned as attacking *O. chalybeus*, the *Homalotylus* probably destroying more of these larvæ.

Oreus nummularis Boisd.—Mr. Crotch in his "Revision of Coccinellidæ," p. 189, says, "This is a rare variety of *O. australasia*, in which the posterior spots are divided." The insect is uniformly smaller, judging from the large numbers seen, and the larvæ of the two species are not alike.

I found the insect first at Whitton, New South Wales, December, 1891, in larvæ, pupæ, and imago state, feeding upon an "Acanthococcid, *Gosayparia* or *Rhicoccus*" (Maskell). Knowing that the insects would feed upon some of our Coccids and surely upon the Black Scale, I was anxious to introduce the same, and in this instance only collected all the larvæ, pupæ, and imagoes that could be found and sent them to Mr. Coquillett, with the request, "only to open the box in a closed room, as some larvæ were infested with parasites, which would be destructive to all our coccinellid larvæ;" and at the same time he was requested to breed the insects in glass jars to avoid all danger of introducing such a deadly enemy to our most beneficial insects. Indeed, the injury and loss to the country that would follow such introduction could not be estimated; in fact, the whole outlook to fight our scale pests successfully with these most effective enemies would be at an end. As a last, but not encouraging hope of much good, we could introduce the secondary parasites. I could not learn anything in regard to those insects from Mr. Coquillett, except that "they were dead" to one, and "they would not feed," to another inquiry.

The same beetles were found later (April 6-11, 1892) at Toowoomba, Queensland, upon orange infested with Black and Red Scales, and three or four specimens only were sent to Mr. Cooper. If but one of these had been a female I venture to say the insect is introduced in California.

Oreus bilanulatus Boisd.—This beetle was found numerous at Harwood, Clarence River, New South Wales, feeding on *Eriococcus conspersus* Mask., upon *Casuarina* sp. Numerous empty pupæ cases were found attached to the leaves, and but two larvæ could be found which were not full grown. As these trees are high and inaccessible for collecting, no doubt these were present in numbers and could not be seen. One pupa found was bred. Two specimens collected on the Tweed River, January 16, 1892, were left in a bottle and both were still living when I came across them on February 11, 1892, having been kept in a room during this time. This is the only instance where insects could be kept living so long without any food, the usual time

during warm weather being about four days, at the end of which time but very few could be found alive had they not been provided with food. Very likely at the time these beetles were ready to go into hibernation. One specimen was also found at Mount Victoria, New South Wales, March 28, 1892, upon *Leptospermum laevigatum* infested with *Eriococcus leptospermi* Mask. The insect appears to be more common in Queensland, as Mr. Tryon informed me.

Mr. Tryon, in "Insects and Fungus Pests," p. 136, says of this beetle as "being an especial enemy of the Glover's scale (*Mytilaspis Gloverii*, Pack), gnawing through the apex of the covering of one individual after another. This is the largest of all the *Oreus* and its introduction upon our scales would be highly advisable. Many specimens were sent to Mr. Coquillett.

Trichoreus cinctus Blackb.—Rev. Blackburn described this insect under this name* from specimens bred, the pupa of which was found attached to small rootlets of Moreton Bay Fig *Ficus macrophylla* Desfontaines), on the Clarence River, New South Wales. Several empty pupae and parasitized larvae were also present, showing that this curious form is not exempt from the attacks of the *Homalotylus* parasite. The insect is without doubt a coccid feeder. Those trees are usually very large, the branches upon old trees being a hundred or more feet in height and impossible to examine. The leaves are always attacked by a Psyllid, the larva of which sit on the under side of the leaf, and causing here a batch of rubber to form under which they are hidden, only coming forth in pupa form, from which the mature insect escapes. It may be these that the beetles attack. In Coccidæ *Aspidiotus nerii* Comst. is always found in large numbers upon this as well as *Erubigenosa* Desfontaines, around Sydney, and as this scale is very common in Australia it may also occur upon these trees in the "bush;" upon this the *Trichoreus* is more likely to feed. Its larva resembles that of *Platylabus lividigaster* Muls., but has a single row of long, lateral spines.

Anisoreus affinis Crotch.—A small, yellowish spiny larva not unlike that of the earlier stages of *Oreus chalybeus* Boisd. It feeds upon *Chionaspis citri* Comst., in the Fiji Islands. They pupate usually on the leaves and the beetle lays its eggs in a similar manner to *Oreus*. I had quite a number of these insects in all stages when I left Fiji and brought them on ice to Sydney and upon arrival there but few were found dead; here they were fed and again placed on ice eleven days later, but not one of them was living on arrival in San Francisco.

Chryptolabus Montrouzieri Muls.—One of the most numerous and useful insects for various coccids, but especially the various Mealy Bugs (*Dactylopius*).

The beetle is very common in Queensland and also in New South Wales, and may be found upon almost any shrub or tree infested with these latter scales. At Brisbane its larvae were seen by the thousands, both on my former and last trips, upon the bunya-bunya trees, *Araucaria Bidwelli* Hooker, and feeding here upon *Dactylopius aurilatus* Mask., a coccid introduced into New Zealand, where it is very numerous upon these trees and has as yet no enemies. The introduction of this beetle in that as well as any country would be highly advisable and we could find no better natural enemies for the green-house pests, where this beetle would prosper and keep the plants free from the Mealy Bugs and Black Scale. Mr. Tryon,† in speaking of the beneficial work of the coccinellidæ, remarks of this very insect: "To mention but a single instance, that of a small black beetle reddened at each extremity, belonging to the group Scymnides and named *Chryptolabus*. The larva of this is a small active grub, measuring about one-quarter of an inch in length, covered above with six rows of contiguous, elongated, white, mealy, secreted appendages. Quite recently the bunya-bunyas and other arriacarationous trees growing about Brisbane have been infested by a coccid insect, an apparently undescribed species

* Further notes on Australian Coleoptera with description of new genera and species. By the Rev. T. Blackburn, B. A. From the Transactions of the Royal Society of South Australia, 1892, xi, p. 73.

† Insects and Fungus Pests, p. 16.

of *Dactylopius*, which affects especially the spot where the leaves and branches unite, and the parasites were at one time so numerous that the death of this valuable tree from their attacks seemed very imminent. However, the *Chryptolemus* beetle also visited the Arancarias and in some places its larvæ occurred in such profusion that the trunks of these trees and the ground around their bases looked as if flour had been dusted in patches here and there upon them. Both in its adult and larval condition it waged war upon the coccid insects, and as a result these trees are saved from destruction. This friendly insect is none other than the one which is met with on various native trees, especially acacias, and also on the citrus and other economic plants of our gardens. These it also visits for the purpose of ridding them or at least checking the increase of the various scale insects, especially those belonging to the Lecanidæ, which infest these trees, and this pest it literally mows down to the surface of the leaves, so great is its voracity."

The insect was met with in almost all places visited, and breeding, besides, upon all the Mealy Bugs (*Dactylopius*), on various species of *Lecanium*, *Eriococcens* (n. sp. Maskell), upon *Cacuarina* at Whitton, New South Wales, upon *Eriococcus leptosperui* Mask., around Sydney and Mount Victoria, upon *Eriococcus Tepperi* Mask., on *Eucalyptus* at Parramatta, and upon *Rhizococcus araucaria* Mask., on *Araucaria excelsior* at Sydney. A large bush of *Eucalyptus* badly infested with *Eriococcus Tepperi* was a favorable "hunting ground" for gathering eggs and larvæ of *Thalpochores cocciphaga* Meyr., and when these beetles with their voracious appetite appeared upon the bush it was soon clear of all coccids.

While the work of these larvæ upon soft coccids is something remarkable, when it comes to the harder insects, as for instance *Lecanium*, it is by no means so effective. The beetle was repeatedly bred in confinement in large numbers, in the hope of rearing parasites from the larvæ, but I failed to do so, and this may be one of the very few coccinellid larvæ of Australia that are not attacked by internal parasites. The white, powdery covering of the larvæ is no doubt a protection against the enemies; in fact the larvæ with its covering mimics many scales upon which it feeds.

The beetles were sent over here by every steamer from Australia and should be introduced. I look for their appearance at Hon. Elwood Cooper's place, who received some and liberated them upon the Black Scale. Mr. Coquillett, who received the most, informed me of having sent the living beetles to Washington. The beneficial work of this beetle could not be estimated in some of the tropical countries, such as the Hawaiian Islands, which abound with *Dactylopidæ* and *Lecanidæ*. The insect was also found in New Caledonia upon *Lecanium longitum* Douglass, on guava, and upon *Lecanium cassiniæ* Mask, on oleander.

Boculus fourueti Muls.—I have bred this insect from a larva resembling that of the *Chryptolemus*, but somewhat more roundish and covered with a denser mass of white, cottony exudation. They were feeding upon peculiar large, flat *Dactylopius* found under the bark of various *Eucalyptus* at Melbourne. The beetle was also met with at Toowoomba, Queensland.

Boculus conreuxi Blackb.*—But two specimens of this were retained from material collected on the Richmond River, New South Wales. One or both of these *Boculi* may have been sent to California, as everything collected was forwarded and only occasionally specimens were saved.

Platymus lividigaster Muls.—Rarely found around Sydney upon orange; is more numerous northward, common at Brisbane. This peculiar larva, with a double row of lateral, long, fleshy spines, was found preying upon *Aphis* on orange at Harwood, New South Wales, January 1, 1892. Mr. Tryon has shown me this insect, with the following localities: "Cairnes, Hamilton, Wootoolah, and Brisbane." He describes an insect agreeing with this on page 134 of his *Insects and Fungus Pests*, as an

* Rev. Blackburn described this new form in Transactions of the Royal Society of South Australia, 1892, XI, p. 72.

enemy to *Aspidiotus ficus* Riley, which scale I have not seen in Australia, and he probably refers to the common *A. rossi* Mask.

Vedalia cardinalis Muls.—Reports have been circulated in Australia that this valuable little beetle is not a native of that country, notwithstanding my statements made as having found the same in various places during my former visit. Before my departure on this trip Prof. Riley requested me, if possible, to try to send the insect to the minister of agriculture at Cape Town, which I did, paying the expenses (\$5) out of my expense fund. On my arrival in Auckland, New Zealand, the insect was present in one of the parks in all stages, and some two hundred and fifty eggs, larvæ, pupæ, and beetles collected on October 8, 1891, were taken to Sydney and fed until a direct steamer left for the Cape on January 30, 1892. During this time the insects were repeatedly bred and kept in a cool chamber when not in Sydney. When shipped, the insects, chiefly eggs and larvæ, were furnished with plenty of food, *Icerya*, on sticks fastened to the box with screws, and the steward on steamer said that ice would be taken on board at Melbourne about one week later, and he faithfully promised me to place the parcel containing the insects on the same, which, however, was not done. In a letter received from the honorable Secretary Fisher, dated March 5, 1892, I was informed that but very few of the insects reached there alive.

On this last trip the beetle was first met with in Australia, at Mulgoa, New South Wales, December 6, 1891, but one specimen, upon *Eucalyptus*, infested with *Eriococcus*. The second specimen was found at Harwood, New South Wales, January 1, 1892, upon *Casuarina*, infested with *Monophlebus fuscus* Mask. Upon the same trees a second species of these beetles was found and subsequently identified for me as *Norius bellus* Blackb. Numbers of empty pupæ skins were present on these leaves near the ground below the trees, clearly indicating that the food of these beetles existed upon the same; and I was not mistaken in my surmise, for *V. cardinalis* was found in large numbers preying upon this *Monophlebus* on same trees at Sydney, January 31, 1892. The tree tops were examined and the *vedalia* larvæ were actually seen feeding upon the *Monophlebid* and were subsequently bred upon the same.

During all summer a colony of *Icerya* in one of the streets of Sydney was watched and the *Vedalia* did not appear upon the same before January, and at the end of one month all the scales had been devoured. During all the latter part of summer the beetles were common in parks at Sydney, and I cannot see clearly how an insect so common can be overlooked by parties in search thereof. The beetle seems to be well distributed all over Australia, as specimens were seen in the museum at Brisbane collected at that place; two specimens from west Australia were found in the museum collection at Sydney, and, as Mr. Skuse informed me, must have been there for the last dozen years or more. It was again met with at Adelaide in large numbers upon the same trees as found on former visit.

As I have stated in my report of first trip, "this beetle must feed on other scales than the *Icerya* and very likely will feed upon some of the *Monophlebid*s." The discovery of its feeding upon *Monophlebus fuscus* Mask, upon *Casuarina*, will make it easier to search for the same, if necessary, and no doubt they can always be found in New South Wales and southern Queensland. Not in one instance did I meet with the *Vedalia* upon *Icerya* in any orchard or forest in these two colonies. Here the most active *Norius*, introduced into California, is constantly in search of the solitary specimens of *Icerya*, and, strange to say, if but a single specimen is present upon one of a dozen large orange trees, this little beetle will find it and leave its eggs upon the same.

Norius koebelei Olliff.*—The insects, three in number, were met with first on October 28-29, 1891, at Parramatta, New South Wales, resting upon the surface of

* Mr. Olliff informed me that he described the insect under this name, and Rev. Mr. Blackburn, to whom a specimen was sent, also informed me that Mr. Olliff had described the insect. I have not seen the description.

orange leaves. At Toowoomba, November 11-12, 1891, numerous eggs were found upon full grown *Icerya*, larvæ of various sizes feeding upon this scale. Eight of these, nearly full grown, were found within an egg sac and pupæ upon leaves and branches near the devoured scales. Also two specimens upon orange at Brisbane. Again at Toowoomba, November 14, 1891, upon orange many specimens were found, and also upon *Eugenia* sp. From an unusually large and nice specimens of *Icerya* with large egg mass, found on orange and placed in a pill box, twelve fully grown larvæ of this beetle were found in the same the following day, all having developed within the one egg sac. One of these pupated on November 15, 1891, and the beetle came out six days later, November 21, 1891. Two specimens of this beetle were seen in the museum collection at Brisbane, and Mr. Olliff, at Sydney, possessed one specimen that was collected at Parramatta. This appears to be the principal enemy of the *Icerya purchasii* Mask., in New South Wales and Queensland, as it was in fact the only species found feeding upon this scale in the country; while in the city of Sidney it is the *Vedalia cardinalia* Muls. that keeps the trees free from *Icerya*, while in the country this seems to feed upon *Monophlebus* chiefly. Specimens of this interesting and valuable insect were repeatedly sent to Mr. Coquillett, yet Mr. Craw has, from three specimens received, succeeded in breeding the same and thousands have already been distributed. This will prove a valuable addition in keeping the *Icerya* in check, and, from what I have observed in Australia, its very active habits in hunting up solitary specimens of scales upon large trees in the country will admirably fit it to keep away all danger of the *Icerya* ever again becoming established in large numbers for any length of time. I have found a new species of *Icerya* in Australia that lives upon *Leptospermum larigatum*, but only an occasional specimen could be found and no enemies were observed to feed upon the same. No doubt it is also this little *Novius* that breeds upon this.

Novius bellus Blackb.—Another of the valuable enemies for *Icerya*, although not found preying upon the same, still I am confident it will devour them as well as the the two foregoing species. The beetles were met with in company with *Vedalia cardinalis* Muls., and feeding as this upon *Monophlebus fuscus* Mask., upon *Casuarina* at Harwood, New South Wales. Numerous empty pupæ skins were present upon the leaves of these trees, which may belong to either of the species. The first specimen was found near Gosford, New South Wales, upon a shrub in an immediate location to *Casuarina*. The insect was described from specimens in Mr. French's collection, who, as he informed me, had received the same from one of his correspondents. Mr. French tried a dozen different coccids, none of which they would eat, yet he did not give *Icerya* or *Monophlebus*.

Erithionyx lanosus Blackb.—This insect was found at Gosford, New South Wales. December, 1891, upon *Cyncarpia laurifolia* infested with *Aspidiotus cyncarpiae* Mask., *Chionaspis eugeniæ* Mask., and *Dactylopius* sp. here not in large numbers. It was quite numerous at Toowoomba, Queensland, upon orange infested with Red and Black Scale, and here they were found in copulation, as well as upon *Eugenia* sp. infested with *Chionaspis eugeniæ* Mask. The beetle was observed to feed upon this *Chionaspis* on a species of *Dracæna*. Numbers were sent to California on several occasions, and they may be expected to feed upon *Chionaspis* with us and probably also other scales. The larva of this beetle was not found.

Seymnodes koebelci Blackb.—The economic value of this insect could not be studied in Australia, as no specimens were found, excepting in rare instances, upon any of the cultivated trees or such coccids found thereon. The insect shows a resemblance to the valuable *Rhizobius*, and doubtless will breed with us upon *Chionaspis*, and, likely, *Lecanium*. It was found most numerous, and during the whole time of my stay in Australia, upon *Banksia serrata*, around Sydney, where, on July 7 and 8, 1892, a few larvæ were found, likely belonging to this insect. One of these was brought to California, but finally died without pupating. This larva is unlike any

of the many bred while in Australia, and comes closest to that of *Scymnus notescens* Blackb., which is also much flattened and having a row of lateral spines dissimilar to any Scymnid larva that I am acquainted with. In these the lateral spines are longer and each bearing again numerous spinules and bristles. They were found feeding on a small coccid covered with a white felted matter, apparently a *Fiorina*. The same insect was also found in the Blue Mountains upon *Leptospermum* and here feeding on *Eriococcus leptospermi* Mask.

Another form of this beetle, which Rev. Mr. Blackburn named "*var. varipes*," was found at Gosford, New South Wales, upon *Cynocarpia laurifolia* infested with *Chionaspis eugeniae* Mask., *Aspidiotus cynocarpiae* Mask., and on Dactylopid. This same variety had also been found at Toowoomba, Queensland, upon *Eugenia* sp., on which the same *Chionaspis* was present, and at this place also upon orange infested with Red and Black Scales. Both these varieties were sent to Los Angeles with the request to liberate the same in orchard with Black and Red Scales. A number of both forms were sent to Hon. Ellwood Cooper. These as well as all other material sent reached him in May, and were liberated in excellent condition upon the Black Scale on olive. I could not yet see the insect on September 3, 1892, at his place. Some two hundred specimens of *S. koebelci* brought home were liberated upon orange infested with Black Scale at Hayward's during August.

Scymnus notescens Blackb.—This beetle, although not very common, appears to be well distributed, as it was found in South Australia, Victoria, New South Wales, and Queensland. It was met with most numerous upon orange, but also upon *Acacia*, myrtle, etc., at Toowoomba; upon *Casuarina* at Whitton, New South Wales, and at Adelaide it was found in large numbers and in all stages feeding upon Aphids on corn. The beetle was repeatedly sent to California.

Scymnus flavifrons Blackb.—One of the smallest and most common of all the Scymnids found. Its food appears to be various, and it may be expected to feed upon most of our scales, and positively Lecanidiinae. Found the same at Toowoomba, Queensland, upon orange infested with Red and Black Scales; upon *Acacia* infested with an *Aspidiotus*, and on *A. eucalypti* Mask., upon eucalyptus; at Gosford, New South Wales, upon *Cynocarpia laurifolia* infested with *Aspidiotus cynocarpiae* Mask., and *Chionaspis eugeniae* Mask., near Sydney and at Mount Victoria, upon *Leptospermum larigatum* F. v. Mueller, feeding here in very large numbers—both in larva and imago state—upon *Eriococcus leptospermi* Mask. It was always numerous at Parramatta, and from a lot of larvæ and pupæ saved from a small bush infested with *Lecanium cassiniae* Mask. parasites were bred from the larvæ and most of the pupæ were found infested with a small chalcid. A form closely related to this, and named by Rev. Blackburn *Scymnus tenebricosus* Bohem., was found with the foregoing upon *Eriococcus leptospermi* Mask., as well as upon *Rhizococcus araucariae* Mask. A third form found upon *Eriococcus Tepperi* Mask., upon one of the stringy bark eucalypti at Mulgoa, New South Wales, is also placed here. This was very numerous, and its larvæ—of which unfortunately no specimens were saved—were present by the hundreds. They resemble those of *S. flavifrons* Blackb., but are about twice its size, as is also the mature insect. Some twenty-five of these larvæ kept in confinement at Sydney began to pupate on December 8, 1891, becoming partly covered with white powery dust as they began to shrink. On return to Sydney, December 19, 1891, all the beetles had already hatched out. The same form was also found at Mount Victoria and feeding upon *Eriococcus leptospermi* Mask. Large numbers of the beetles were sent to California.

Scymnus sydneyensis Blackb.—This beetle was found at Parramatta, New South Wales, upon orange with both Red and Black Scales, and upon a small shrub infested with *Lecanium cassiniae* Mask.; at Mulgoa, New South Wales, December 4, 1891, upon *Acacia*, *Eucalyptus*, *Leptospermum*, and orange, and at the same place, upon a former visit, on peach trees infested with Aphids. It was found at Toowoomba, November 12, 1891, and again at the same place in large numbers April 6-11, 1892,

upon myrtle and orange. Was also met with in other places. Its food appears to be various and with us it will feed no doubt on *Lecanium* as well as *Aspidiotus*, and likely upon *Chionaspis*. This insect was sent to California in numbers.

Scymnus whittonensis Blackb.—The insect was found at Whitton, New South Wales, upon various trees and very likely feeding upon *Aspidiotus*; also at Parramatta upon orange infested with the Red Scale and bred from a small larva covered all over with long, curled, white cottony appendages. The beetle was sent to California.

Scymnus queenslandicus Blackb.—This is another of the species sent here. It was found chiefly upon orange affected by black and red scales in New South Wales and Queensland. The species sent from New Zealand, as *Scymnus acceptus*, *S. consors*, *S. villosus*, *S. flavihirtus*, *S. fagus*, and *S. picinus*, were chiefly found upon *Aspidiotus* and *Ctenochiton*. The last named closely resembles the common Australian *Rhizobius satellus* Blackb.

Scymnus australasiae Blackb.—Another quite common form found in New South Wales upon orange, and here probably feeding upon the Red Scale; also upon *Lecanium cassiinae* Mask. at Parramatta; numerous at Toowoomba, Queensland, upon orange, and at various other places. Without doubt it will feed upon the Red Scale in California. The genus *Rhizobius* is largely represented in Australia. Crotch mentions eight species from that country, one from Europe, two from Cape of Good Hope, and one from Madeira. I have but four species of this, including *Rodatus boucardi* Crotch, which was placed under *Rhizobius* by Rev. Mr. Blackburn. All the others have been or will be described by Rev. Mr. Blackburn in the Transactions of the Royal Society of South Australia. The insects closely resemble *Scymnus* in their habits, are great devourers of various coccids, and larvæ of the same can be found at any time during the year. I can not state the exact number of broods, but should think there are at least six.* Some of the species are quite large, and we can hope for the best results from all the introduced species of this group. As yet I am only aware of two of the species breeding in California, but others will turn up. *R. ventralis* Muls. and *R. debilis* Blackb. were both found in numbers with Hon. Ellwood Cooper, at Santa Barbara, on September 4, 1892, upon *Lecanium oleæ* Bernard, and the last-named species is breeding upon *Aspidiotus perniciosus* Comst., here at Alameda.

Rhizobius boucardi Crotch.—This insect is described from Moreton Bay, Queensland. I found but one single specimen near Sydney, under bark of *Eucalyptus*, and a second seen in same place was lost. On the same tree numbers of cocoons of *Thalpochares* were found, showing that the tree was infested with *Eriococcus*, upon which this beetle no doubt feeds. It may become of value in feeding upon some of our coccids—very likely *Lecanium*—if introduced, and as this is probably the largest of all the *Rhizobiids*, measuring over 6 mm. in length, it would prove a valuable addition to the already introduced species. The species will prove to be common in Queensland.

Rhizobius ventralis Erich.—One of the most numerous of all the Coccinellidæ in South Australia and Victoria, becoming more rare toward Queensland. During my former trip I have actually seen these beetles by the hundreds sitting under bark of *Eucalyptus* that was infested with *Eriococcus eucalypti* Mask., upon which they feed, at Melbourne and Adelaide. I did not recognize the insect at first on this last trip at Sydney, where they were found upon various *Lecanium*, on citrus, and on other trees; in fact, the larvæ feeding upon these are much lighter in color than those feeding on *Eriococcus*. I saw in this the most effective enemy for all our *Lecanium* and a good supply of the mature beetles was sent to California by every steamer. Hon.

* It can not be stated, nor even properly estimated, the number of broods these insects have. These will vary according to the coccids they feed upon. *R. ventralis* may go through the whole transformation in about three weeks upon soft food, such as *Eriococcus*, while upon other coccids not in favorable condition the life history may be prolonged to two months or even more. I have found numerous beetles hibernating in dry season at Melbourne and awaiting the return of rain and with it the *Eriococcus*.

Ellwood Cooper, who received the insects on two occasions, has in both instances succeeded in introducing the same upon *L. olea*. On a visit to his orchard on September 4, 1892, larvæ of all sizes as well as mature insects could be found in numbers at both places where they had been liberated. Large numbers of these beetles were sent over here on my former trip, and Prof. Webster also brought a number of them from Tasmania, all of which were sent to Los Angeles, yet none of them were liberated at that nor apparently this time. The beetles were met with feeding upon all species of *Lecanium* upon citrus trees; upon *Lecanium* sp. on guava at Harwood, New South Wales, where two other species of *Rhizobius* were also present; upon *Banksia serrata* infested with *Fiorina* (?) and *Chionaspis eugenie* Mask.; at Mount Victoria upon *Eriococcus leptospermi* Mask., upon *Leptospermum laevigatum* F. V. Mueller; at Whitton, New South Wales upon *Casuarina* and feeding here upon "*Gossyparia*, n. sp. or *Rhizococcus* (?) Maskell," also breeding upon *Rhizococcus araucariæ* Mask., on *Araucaria excelsa* R. Brown, at Sydney. But the chief food seems to be the various *Eriococcus* in Australia. It was in this species and *R. debilis* Blackb., that freed a large tree in the botanical gardens at Sydney within a comparatively short time of a soft species of *Lecanium* that was covering the leaves, and shortly after all the *Rhizococcus* upon an *Araucaria* close by were devoured by them. At the same place this insect was also numerous upon *Lecanium cassiniæ* Mask., on oleander. The larva of this beetle is preyed upon by a parasite, which at times destroys the greater part of them. Fortunately, by a provision of nature this parasite is kept in check by secondary parasites. Twenty-one larvæ of this beetle collected at Melbourne under bark of *Eucalyptus* infested with *Eriococcus*, upon which they had fed, were parasitized by eighty-four larvæ of *Homalotylus* sp.; of these but fifteen parasites issued, while all the rest were destroyed by two species of secondary parasites. Should the parasite ever appear on the *Rhizobius* larva in California, which would render its value as an enemy to scale insects of much less importance, we could easily and with advantage introduce these secondary parasites by simply shipping over a few hundred infested larvæ of the *Rhizobius* or pupariæ of the *Homalotylus*. It is possible, but not likely, since we have no *Rhizobius* in this country, that the parasite was introduced on my former trip to Australia, as at that time a few larvæ of this beetle were sent over here, but all these were kept confined in a tent with *Icerya*, upon which they failed to feed, and all perished. Had the beetle been introduced three years ago they would now be present in the State by the million.

Rhizobius debilis Blackb.—Next to *R. ventralis* Er., the most numerous of all the Rhizobiids, and will prove one of the best acquisitions we could get. The insect was first met with during 1889 while unpacking a lot of leaves of *Ficus macrophylla* full of *Aspidiotus nerii* Bouche, brought from Sydney. The beetle had developed within the paper. It is very numerous in New South Wales upon *Leptospermum laevigatum* F. V. Mueller, that are infested with *Eriococcus leptospermi* Mask., as well as upon *Casuarina* infested with *E. turgipes* Mask. and *Monophlebus fuscus* Mask., but not likely feeding upon the latter. It is common upon *Araucaria excelsa* infested with *Rhizococcus araucariæ* Mask., and always found upon orange at Parramatta. While at Adelaide, South Australia, Mr. Grasby, of the "Garden and Field," kindly took me to an olive orchard where *Lecanium cassiniæ* Mask. was plentiful upon some of the trees, and here this beetle with its larvæ, was present by the hundreds. Here, as all over Australia the fatal parasites were in full sway upon this beneficial insect, the *Homalotylus* destroying the larvæ and a smaller chalcid the pupæ of the beetle.

Numbers of these beetles were sent to California by every steamer, and Mr. Coquillett returned to me a lot of alcoholic specimens. The beetle is doing remarkably well at Mr. Cooper's place upon *Lecanium oleæ* Beru., and from two specimens left in my yard upon prune trees infested with *Aspidiotus perniciosus* Comst., by Mr. Craw, on May 14, 1892; they have also done well. Already during August larvæ of all sizes as well as imagoes were present, and these were found upon other trees as well during September.

Rhizobius satellus Blackb.—This had always been the most numerous insect upon citrus trees at Paramatta, here preying upon the Red Scale. I look for its increase in this country with great interest. Upon my hunting ground I had three wild lemon trees bordering a forest, and somewhat apart from the orchard, badly affected with *A. auranti* Mask., so much so that any fruit-grower in California would have given them up for lost and would speedily have applied his "wash" or "fumigation" as a last hope. Here this beetle, *Rhizobius*, stepped in and in such numbers that the larvæ could be found by the thousands. At the end of about six weeks the work was completed and the trees left completely free of scales. With the exception of losing a few leaves the trees did not suffer in the least. Both the *Oreus*, *O. chalybeus*, and *O. australasia*, as well as numerous other species, were also present, but not in such large numbers. The insect was met with at all places visited in New South Wales and Queensland, and with us will no doubt feed upon many of the *Aspidiotus* and probably various other coccids. Some six to eight thousand specimens of this beetle were collected and sent here, most of these to Los Angeles. No parasites were observed preying upon the larvæ of this insect, yet it is more than likely that this also has its enemies. I found the larvæ still feeding on my return from Fiji, July 4-6, at Paramatta, although midwinter, when many of the other Ladybirds were hibernating.

Rhizobius fugax Blackb.—Another of the larger species found in few specimens at Melbourne and quite numerous at Whitton, New South Wales, upon *Casuarina* infested with an *Acanthococcid*. The insect was sent to Los Angeles.

Rhizobius dorsalis Blackb.—Another common and valuable insect especially for the Black Scale, and I look for its appearance in California at Hon. Ellwood Cooper's place, where specimens were liberated. This was met with in New South Wales, near Sydney, upon *Leptospermum larigatum* and feeding upon *Eriococcus leptospermi* Mask., on *Rhizococcus araucaria* Mask., and black scale; at Gosford upon *Cyncarpia laurifolia*, upon which tree likely another coccid may be present than those observed. Larvæ found at Mount Victoria upon *Leptospermum* differ from those of *R. ventralis* and *R. debilis*, with which they were found, by their lighter and more reddish color. The insect was repeatedly sent to Los Angeles, and in one consignment to Elwood.

Rhizobius cyaneus Blackb.—Another new form of this valuable beetle, which may become of value if introduced. The insect was found at Mulgoa, New South Wales, upon *Eucalyptus* infested with *Eriococcus Tepperi* Mask. A much larger species was seen at the same place, which may have been *R. xanthus* Muls., which is reported from Victoria.

Rhizobius speculifer Blackb.—This insect was always found in numbers at Paramatta, New South Wales, upon citrus trees infested with coccids. The mature beetle was observed to feed upon the males of *Chionaspis citri* Comstock. Also numerous at Toowoomba, Queensland, upon orange and on *Eugenia* upon *Chionaspis eugenia* Mask. The beetle was sent to California in numbers.

Rhizobius toowoombæ Blackb.—Was found in Victoria, New South Wales, and Queensland; most numerous at the latter place. The beetle was bred from larvæ found feeding upon *Aspidiotus nerii* Bonche, at Melbourne. It is always common upon orange infested with the red scale. The mature insect was sent to California in numbers, and may be expected here, as do most of these forms, to feed upon most any coccid. Mr. Tryon in "Insects and Fungus Pests," p. 131, mentions and describes a *Rhizobius* feeding upon the red scale at Toowoomba, the description agreeing with this species, which is one of the most numerous in that locality.

Rhizobius aurantii Blackb.—A form found at Toowoomba upon Red Scale affected trees and without doubt feeding upon this as well as other coccids. As previously stated, no insect was ever killed simply for specimens, only forms that positively looked strange and of which I wanted to get the life history. This also appeared to be one of the forms of which only a single specimen was saved, and which was

described by Rev. Mr. Blackburn. Specimens must have come to Los Angeles, and if once numerous upon the coccids here there is ample time to destroy the same for collections.

Rhizobius cactus Blackb.—Another of the common and beneficial insects. It was found at Adelaide, South Australia, upon olive and feeding on *Lecanium cassinia* Mask. Numerous at Paramatta, New South Wales, upon orange infested with red scale as well as other coccids, and upon *acacia* infested with a Deaspid; at Gosford, New South Wales, upon *Cynocarpia laurifolia*; on Clarence, Richmond, and Tweed rivers upon various shrubs and trees; at Brisbane upon orange infested with *A. aurantii* Mask., and at Toowoomba upon same trees, as well as *Acacia*. The species was sent in numbers to California.

Rhizobius (hirtellus) Crotch (?)—This insect has not yet been properly identified. The Rev. Mr. Blackburn at one time sent me this name, but reported later that this is not the insect. It differs from the description of this species. Always very numerous at Paramatta, New South Wales, upon citrus trees infested with *A. aurantii* Mask., *Mytilaspis Gloveri* Pack., and *Chionaspis citri* Comst. The beetle was repeatedly observed feeding upon this latter coccid, also met with in many other places visited. Many specimens were sent by every steamer. The insect was not bred.

Rhizobius pulcher Blackb.—A very common but small beetle, most numerous upon *acacia* infested with a species of Diaspid, but also common on orange. It was met with at Melbourne and northward to Brisbane; at Mount Victoria, New South Wales, upon *Leptospermum* infested with *Eriococcus leptospermi* Mask. Numerous specimens were sent to California.

Rhizobius australis Blackb.—One of the largest of the Rhizobiids. Found in South Australia, Victoria, and New South Wales. The insect was bred from larvæ found under bark of various Eucalyptus at Melbourne, feeding upon a species of Dactylopius. The insect was not sent to California. These Rhizobiids so far named are from the scant material retained. The list of the species sent here is by no means complete, yet I did not consider it proper to waste a single insect when not necessary. We want every one of these valuable beetles here to introduce them, and so far as the name or life history is concerned, as long as we know the insect is beneficial, and for this I am responsible, that is a secondary matter of very little importance and can be studied by our grandchildren, for that matter. Among the alcoholic specimens received from Mr. Coquillett there are two species of *Rhizobius* not included here, as no specimens of the same were retained in Australia. Besides these, several other species are yet to be worked up.

Midus pygmaeus Blackb.—This insect was bred from a white, tufted larva found upon orange at Parramatta, New South Wales. It was also collected in considerable numbers at Toowoomba, Queensland, upon the same trees. Became quite numerous at Sydney during March, upon oleander and *Pittosporum* infested with a species of *Dactylopius*, upon which they appear to feed. Was also found at Mulgoa, New South Wales, upon *Eucalyptus*. Many specimens were sent to California.

Lipernes subviridis Blackb.—A very small and common insect upon citrus trees infested with Red Scale, *Chionaspis citri* and *Mytilaspis Gloveri*. The larva, with its long, white, mealy, secreted appendages, was repeatedly bred. Also found at Gosford, New South Wales, upon *Cynocarpia*; on the Richmond River and at Toowoomba upon orange. Was always among the material sent to California.

Gymnoscymnus 4-maculatus Blackb.—This insect was found at Gosford, New South Wales, upon *Cynocarpia laurifolia*. Apparently a rare insect in localities visited, and but a limited number could be obtained for California.

Cycloscymnus minutus Blackb.—Found this beetle very numerous at Mount Victoria, New South Wales, March 25, 1892, upon *Leptospermum larigatum* infested with *Eriococcus leptospermi* Mask. The insect was sent to California.

Cyrena nigellum Blackb.—The beetle was found at Adelaide, South Australia, in company with *Rhizobius debilis* Blackb., and feeding with this upon *Lecanium cassi-*

nia Mask. upon olive. Its larva is a small, pale, flat, roundish grub, covered all over with white cottony exudation. The beetle was not found in great numbers, but some were sent here.

Seraugium hirtuosum Blackb.—Was found quite numerous at Toowoomba, Queensland, November, 1891, and April, 1892, upon orange infested with red and black scales. Many were forwarded to California.

Seraugium maculigerum Blackb.—This insect was found very numerous during the early part of the summer at Parramatta, New South Wales, upon orange infested with Red Scale, and was also found in large numbers upon a tree in the botanical gardens at Sydney that was infested with the same coccid. Repeatedly sent to California. The above are the principal beneficial Coccinellidæ studied in Australia, so far as identified for me. The rest, not yet named, consist of groups similar to those mentioned here. Many of these are Seymuids and Rhizobiids and can be dealt with at some future time. A few injurious Coccinellidæ were met with and I will give an account of the same.

Epilachna vigintiocto-punctata Fab.—This is a very numerous and destructive insect in New South Wales and Queensland. It was met with in all localities visited and care was necessary in not mixing this with *Coccinella conformis* Boisd. in collecting, which it greatly resembles, especially if worn, and as both species are found together upon orange and other trees. The larva was often bred on potato leaves and other solanaceous plants, and I did not obtain any parasites, but Mr. Tryon reports having bred parasites preying upon these larvæ. The mature insect will apparently occasionally feed upon Aphidæ. I have caught one specimen in the act of devouring the eggs of *Oreus* on the underside of an orange leaf; a second specimen was found at Sydney, on April 23, 1892, upon *Ficus rubiginosa* Desfontains, and feeding upon *Aspidiotus nerii* Bouche.

Epilachna vigintisex-punctata Boisd.—Was met with in the Richmond district, as well as at Toowoomba, and is, like the foregoing, destructive to potato and melon vines.

Epilachna guttato-pustulata Fabr.—Was met with in large numbers on the Clarence River, New South Wales, in the forests, and chiefly upon a species of Ipomæa.

Epilachna Montpriezi var. *Fijiensis*.—This was found in the Fiji Islands, where no particular food plant was observed. Probably the most valuable insect preying upon our larger coccids are the larvæ of a small moth that forms a covering over its back as a protection against the various enemies, and so walks over the plants and trees, devouring large numbers of coccids.

Thalpochares cocciphaga Meyr.—The larvæ of this valuable insect is perhaps most numerous upon various Eucalypti infested with *Eriococcus*, a soft, globular scale entirely covering one or more branches of these trees. The moth lays her eggs on the bark or leaves singly in close proximity to the scales, and the young as they hatch at once begin their destructive work among them. Upon *Lecanium* the young larvæ will at first eat their way under one of the larger scales, devouring the contents within and using the empty shell as a house, so to speak, carrying it around on its back while feeding upon the other scales. As this becomes too small, other empty scales are spun onto it in addition until the larva becomes grown, which is probably in about three weeks upon these coccids during summer. I had some flourishing young orange trees infested with *Lecanium oleæ*, *L. cassiniæ*, and *L. hesperidum*, this latter species also with male scales, upon which grown larvæ could be found every two weeks. They had to be collected thus often in order to keep some of the scales upon the trees and thereby obtain a certain supply of the larvæ for every steamer leaving Sidney for San Francisco. Upon the appearance of any danger or enemy in its walks the larva will immediately stop and pull the edges of its covering tightly to the bark or surface of the leaf, as the case may be, and so fast and close are they that the edges appear to be spun onto the surface; they are thus not readily removed. This covering is not only a protection against the parasites, but

also against the armies of vicious ants among which they have to live and against birds in mimicking the scales in this covering. If perchance one of these larvae is removed from its covering it will immediately set to work to build a new one. When full grown the larva with its house will search for a convenient place to spin up, which they do most anywhere, exposed upon the twigs, among the dry and curled-up leaves, on stem, etc. But a favorite place is always the forks of branches, a crevice on the stem, or the base of this, partly below ground. Here the house is transformed into a substantial cocoon by spinning up the underside or strongly fastening this part onto the bark. When this is completed the upper side of one end is cut through and here a tube of various lengths, with an angulated closed valve is formed for the future moth to issue. Within this the larva may remain for a few days to a few months before pupating, according to season or circumstances, and if again taken from this they appear as sluggish, helpless grubs, unable to again feed or build another cocoon, and will invariably die. The mature insect is a pretty little moth and most variable in color, from light immaculate gray to dark brown, with strong characteristic markings.

A second species of these moths was found, the larva of which preys upon *Eriococcus Tepperi* Mask., in the Blue Mountains, New South Wales. The full-grown larva of this may easily be distinguished from that of *T. cocciphaga* by the two small shiny black piliferous warts upon the dorsal space on segments three to eight; it forms a softer, finer, and stronger cocoon. About a dozen of these and some one hundred and fifty of *T. cocciphaga* were placed in the olive orchard of Hon. Ellwood Cooper, and no doubt our well-known species at least will make its appearance in time. Over one hundred of *T. cocciphaga* were placed in an orange orchard infested with *Lecanium olivæ* and *L. hesperidum* at Haywards. Mr. Coquillett is also breeding the insect in confinement.

Besides the coccids mentioned, the larva was also found preying upon various other species in Australia, such as *Pulvinaria*, *Icerya*, and, in fact, will feed upon any of the larger coccids if in numbers. At Brisbane I found them feeding upon *Ceroplastes myrica* Linn. (probably this species according to Maskell), a coccid recently introduced in the botanical gardens at that place, and have since spread over a large number of shrubs and trees throughout the city. Dr. Bancroft showed me a dozen mango trees actually covered with these coccids. At Sydney they were feeding also upon *Ceroplastes ceriferus* Anderson, a coccid very destructive to many of the shrubs and trees in the botanical gardens. This coccid appears to be a native of Australia, as it was met with in the woods from Sydney north to Brisbane.

With us these larvae can be expected to prey upon all *Lecanium*, *Pulvinaria*, *Kermes*, *Icerya*, and, in fact, any larger species. I have never found this larva feeding upon the woolly aphid, yet I believe they will do so.

Tineid larva.—Covering the trunks and limbs of citrus trees with a fine silky web interwoven with remains of scales, under which live numerous small caterpillars of a Tineid which devour all the coccids. When full grown they spin an elongated flat silken cocoon in which they pupate, and from this a small gray moth issues.

Upon my first arrival in Sydney on my former trip, Mr. Ramsay, curator of the Australian Museum, called my attention to this valuable little moth, but at that time I did not have an opportunity to look into the matter. Since then Mr. Tryon refers to the same moth ("Insects and Fungus Pests," p. 128) as an enemy of *Chionaspis citri* Comst.* This latter coccid as well as *Mytilaspis Gloveri* Pack., appears to have been introduced into Australia, and they are found very abundant around Paramatta. In two orange orchards adjoining each other, and both of about thirty-five years' standing, the work of the natural enemies to coccids and the interference of man could be admirably studied. One of the proprietors, Mr. T. Brien, who obtained first prize from the New South Wales Agricultural Department

*Doubtless this scale will be found upon wild citrus plants in Queensland as well as in the Fiji Islands.

for the best orchard in the colony, bestowed all the care possible upon his trees. Both of these coccids are very numerous upon his trees, and as a remedy the trunks and limbs were washed with sulphur and lime mixture with which a strong brush was used. About once every year this had to be repeated. In speaking with him on the value of natural enemies of these scales, the gentleman remarked that the same coccids had also been numerous in his neighbor's orchard, and so much so that during one summer many of the trees became whitish, but the following summer all this had disappeared, and the trees ever since kept free of both these scales. It is very evident that the larvæ of this tineid moth had been allowed to go undisturbed and devoured all the coccids upon the trunks and limbs, and those that remained on the outer parts of limbs and leaves were either eaten by the many ladybirds and their larvæ, or destroyed by the fungus *Microcera coccophila*, which by itself frees whole trees of this as well as Red Scale in a short time. Mr. Brien always took the gray and dirty appearance of his trees as evidence that myriads of coccids were upon them, and washed off, with the brush and lime and sulphur mixture, the numerous valuable little caterpillars that were doing their best to free his trees of the coccids, naturally destroying all these, and, by the sulphur wash, preventing the *Microcera* from developing. This must seem plain to everyone, that under such circumstances the operation becomes necessary every year, while in his neighbor's orchard, which had never been sprayed or washed during its existence, and the natural enemies left undisturbed, hardly a single tree can be found with coccids upon it. These tineid larvæ will feed upon most any Diaspidinæ when they are in large numbers, and have repeatedly been found upon the red scale. These larvæ were sent to Washington, and some of them brought with me were liberated upon *Aspidiotus perniciosus* Comst. A similar tineid larva was also observed to feed upon *Chionaspis citri* Comst., in the Fiji Islands, but not in such large numbers, and not producing such large webs upon the surface of bark.

The larva of another and much smaller tineid, black with white markings, is found in large numbers, feeding upon a species of *Ceroplastes* at Sydney, making tunnels under the hard waxy covering and devouring the contents within. This coccid is not yet described. Females of second stage and males were sent to Mr. Maskell.

Another tineid was bred in numbers from a lot of *Icerya* collected at Melbourne and used as food for the *Vedalia*. The larvæ spin all the cottony matter of the scales together and within devoured not only all the eggs, but the coccids as well. The same moth was also bred from larva found preying upon *Lecanium*. This is, if I remember right, the same insect that was brought in such numbers by Mr. Webster from Tasmania, in 1889.

In New Caledonia, upon bamboo badly attacked with a very large green Aphids, that has some cottony exudation on the lower end of its body, and sitting in masses all over the woody part of the plants, batches of empty cocoons of a *Pyralid* or large Tineid were present, the larvæ of this no doubt preying upon this Aphis. I had no time at my disposal here to investigate the matter properly. If tried, this insect may likely become of value in destroying the woolly aphis.

Diplosis koebelci, Skuse, MS.—Mr. Skuse gave me this manuscript name for one of the most interesting and important Cecidomyids, showing the peculiarity of Australian insect life. The mother fly deposits her pale orange-yellow eggs anywhere near a patch of *Dactylopius*, generally near the midrib on underside of leaves where these coccids congregate. They are about three times as long as broad and not uniformly colored, as in places darker orange spots appear. These soon hatch and the young maggots crawl up to and under the mealy bugs and here spin a few silken threads among and fastening them. Under this the short duration of their beneficial work begins. One after another of the coccids is taken hold of and sucked out; the remaining empty skins are either fastened on to their webs, if needed, or thrown to the ground. Often these maggots and their performance

have been watched with profound interest. One, two, or even more of these are hidden together under their slight covering, poking their pointed heads out here and there at the sides, and if one of the mealy bugs comes quietly passing by, it is but an instant until this is fastened down with a silken rope and left helplessly struggling until wanted, or devoured at once as the case may be. So numerous were the larvæ that all the midribs of the leaves of *Pittosporum*, oleander, fig trees, etc., where the coccids were numerous, showed dense masses of dead mealy bugs and remains of such spun together. Probably in about one week the larvæ will close up its surrounding by making a rather dense silken web, within which they pupate. One of the larvæ that spun up on March 25, 1892, produced the mature insect on April 4, 1892, taking about three weeks for the whole transformation. Upon the same *Dactylopius* a small interesting chalcid was bred in large numbers. These lay their eggs singly into the young coccids. The newly hatched maggots will feed on the contents of the mealy bugs and pupate within the apparently blown coccid. This *Dactylopius* became very numerous during February and March, but when the *Diplosis*, the chalcid, together with *Cryptolarnus Montrouzieri* Muls., *Mydus pygmaeus* Blackb., as the principal factors began war upon them, it was but a very short time until the vast army of mealy bugs was reduced to but a few straggling specimens. A similar *Diplosis*, if not the same, is also quite numerous and preying on *Diaspis fimbriata* Mask., a numerous scale upon *Eugenia Smithi* at Sydney, New South Wales. The insect was also bred.

Lestophonus iceryæ Skuse.—On the 11th of March, 1892, three long and narrow pale orange-colored eggs with darker markings were observed upon a full-grown *Icerya purchasii* Mask., at Sydney, placed irregularly upon and close onto the skin, one in front, the second on the side, and the third upon the posterior part of scale. These eggs appeared fresh when first found and the *Icerya* very active; about one week after it appeared to be sickly and finally shrank and dried up. On April 2, 1892, one of the flies came out and the other two the following day. This will show that the time required for transformation of these flies, from egg to mature insect, is about three weeks in moderately warm weather, and naturally the supposition of Mr. Koebele in his "Trip to Australia," that this insect is but about two-brooded is wrong. Two new forms of *Lestophonids* were bred, the one from *Monophlebus fuscus* Mask., infesting *Casuarina* in New South Wales, and the second upon *Monophlebus australis* Mask. This latter closely resembles *L. iceryæ* Skuse, but is about twice as large. All the new *Diptera* were turned over to Mr. Skuse, of the Australian Museum, Sydney, for description. Among these were several new species of *Oscinids* bred from larvæ preying upon various *Aphids*, and one on *Eriococcus eucalypti*. This latter was bred on my former trip and sent to Prof. Riley.*

On March 15, 1892, three small, pale white larvæ fell out of an egg mass of *Icerya purchasii* Mask., used as food for *Norius*. These were placed in a small vial within which they fastened themselves with a sticky fluid on the side of the glass by the last segment and so changed to naked pupæ. After one week these became black and the chalcid issued on March 26, 1892. This proved to be the same insect as bred on my former trip from larvæ found preying on the eggs of *Icerya* and sent to Prof. Riley with notes, who described the insect from specimens received from the late Mr. Crawford, as *Ophelosia crawfordi* Riley.

*Many of the *Aphids* in Australia are found dead and always have a blackish color. From this I bred a small chalcid apparently parasitic upon this.

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