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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Entomology,
Washington, October 3, 1902.

Sir: I have the honor to transmit herewith the manuscript of the Proceedings of the Fourteenth Annual Meeting of the Association of Economic Entomologists, which was held at Pittsburg, Pa., June 27 and 28, 1902. The papers presented at these meetings are always of the highest economic importance, and the present series is of an unusually practical nature. The Department of Agriculture has hitherto published the secretary's reports as bulletins of this Division, and I therefore recommend the publication of the manuscript here presented as Bulletin No. 37 (new series).

Respectfully,

L. O. Howard,
Entomologist.

Hon. James Wilson,
Secretary of Agriculture.

We have, therefore, as the original home of this insect a naturally shut-off area from which it could not easily escape under the conditions prevailing up to our own times.

The means by which the San Jose scale came from China to America is a matter of interest and offers room for conjecture. The San Jose scale apparently reached California on trees imported by the late James Lick. It was known that this gentleman was a great lover and energetic importer of trees from foreign countries, and my own belief is that he imported from China, possibly through this same Dr. Nevius or some other, the flowering Chinese peach, and brought with it the San Jose scale to his premises. At any rate, I believe that this insect, which should now be known as the *Chinese scale*, came to this country on some ornamental stock from North China.

PRELIMINARY REPORT ON THE IMPORTATION AND PRESENT STATUS OF THE ASIATIC LADYBIRD.

(*Chilocorus similis.*)

By C. L. Marlatt, *Washington, D. C.*

In this place a brief account only will be given of the importation of this ladybird and of the present outlook of the experiment. A detailed account of this insect, giving full life-history studies and other points of interest, will be published elsewhere. It has already been indicated in the foregoing account of the search for the San Jose scale in China and Japan that this ladybird was everywhere present in both of these countries, feeding on the San Jose scale and *Diaspis pentagona*. The latter scale insect, as was pointed out, is common to all eastern Asia, including Japan, and the East Indies, and undoubtedly, from its wide distribution and local occurrence in most out-of-the-way districts, is a native of this region and has been spread about in times so remotely past as to be beyond determination. It is probably a tropical species which has worked northward until practically the whole region as far as Pekin, in China, and the north island of Japan has been covered. Whether the ladybird, *Chilocorus similis*, was in ancient times the natural enemy of the Diaspis can not be determined, although the more wide occurrence of the Diaspis might lead to this idea. This ladybird, however, like other members of its genus, is a general feeder, and will attack other scale insects, even the young of the unarmored scale insects as well as the Diaspine scales. Wherever it was found with the San Jose scale, however, it was very evident that it fed on this scale insect with perhaps even greater readiness than it did on the Diaspis, and in our experimental breeding cages in Washington it has bred faster and done better on the San Jose scale than on the Diaspis.

After finding this ladybird so generally present with the San Jose scale, and apparently so efficient in keeping the latter within reason-

able limits, the desirability of introducing it into America was very evident. While in Japan I was unable to determine whether Mr. Albert Koebele, in any of his numerous importations, had sent this ladybird into California, but it seemed more than probable that he had done so, and I wrote to Mr. Koebele, at Honolulu, H. I., and some months later after I had made my shipments I received information from him that he had sent a lot of material to Mr. Alexander Craw, and that the latter had carried it through the winter successfully, but further than that he knew nothing of it. It is possible that the material introduced by Mr. Koebele has established itself in California. Since my return from the Orient, and within a few days, I have learned from Prof. J. B. Smith that he also had had some specimens of this insect sent to him from Japan by one of his Japanese correspondents. These were liberated at once in the fall in an infested apple orchard in New Jersey and nothing has been seen of the insects since. Professor Smith believing that they perished. Judging from the small percentage of survivors of those which I imported, I think it very likely that Professor Smith's specimens all died during the winter.

As a preliminary experiment to determine the possibility of shipping them across the ocean I collected, about the middle of August, a lot of the beetles in North Japan on trees infested with San Jose scale and carried them about with me in my travels for over two weeks in a tight wooden box with some infested twigs as food. These beetles, kept under conditions which certainly were not very favorable, being among other goods in my baggage, and subject to much shaking, came through the ordeal in perfect condition, and I shipped them to Washington with a lot of others collected, with the assistance of Mr. Hori, about Tokyo.

Three packages were sent about the middle of September, and of this first sending some twenty odd specimens reached Washington in fairly good condition, active, and apparently uninjured, and Mr. Kotinsky, who was given the beetles in charge, from his records is able to say definitely that it was individuals from this first sending that successfully overwintered. A sending two weeks later was made from specimens collected about Yokohama and Tokyo, together with a few taken in the interior hill region. A third sending was made from material collected about Tientsin and later at Shanghai, the specimens at Shanghai being found feeding on the young of a wax scale on holly, the beetles occurring there in considerable numbers. The distance from Shanghai to America by boat is a week or ten days longer than from Japan, and six or seven weeks are required for their arrival at their destination in Washington. The sendings from China were received in rather poor condition, and Mr. Kotinsky assures me that all of the specimens of this lot which were alive when received died during the winter.

On leaving Japan I had made arrangements with the entomological

authorities of the Central Experiment Station at Nishigahara, near Tokyo, to make additional sendings, and a little package was received early in the spring of 1902 from the chief entomologist of the station, Mr. Onuki. This material, however, came in a very bad condition, and the few surviving beetles soon perished.

The material shipped in the first instance by me was in three wooden boxes, two sent through the mails and one personally carried across the Pacific by Miss Laura Bell, whom I had met in Japan, and who kindly promised to mail it to Washington as soon as she landed in Vancouver. All of this material and the subsequent sendings also, so far as I could control them, were mailed to take the Canadian Pacific steamers to get the advantage of the northern and much cooler as well as shorter passage. I am unable to determine, the record having been lost, whether the specimens which overwintered were those personally carried by Miss Bell or those sent through the mail. At any rate, but two individuals survived. It is possible that with proper precautions a much larger number could have been successfully hibernated, but they were kept indoors, and for part of the time in heated rooms, and the survival of two was, under the circumstances, a rather fortunate outcome. Furthermore, many of the beetles were possibly spent ones when collected.

In April, after the eggs were recognized, the beetles and eggs were transferred to and kept in a jar in the greenhouse on fresh scale-infested twigs until larvæ were produced in considerable numbers. Undoubtedly a good many of the eggs first laid were overlooked because of the peculiar habits of oviposition of the beetle, which seem not to have been previously noted. Later on the eggs were discovered and some 50 larvæ were reared in this manner indoors. Afterwards the beetles and the larvæ were from time to time transferred to a big out-of-door cage, 6 feet square and 9 feet high, inclosing a plum tree thickly infested with *Diaspis pentagona*. Ultimately all of the indoor-bred larvæ were transferred to this tree, about 100 altogether, and, judging from the rate of oviposition, at least 100 additional eggs were deposited on the tree by the parent beetle before the latter perished. So far as we could determine, but one of the two surviving beetles was a female, and 200 eggs or more were obtained from her after a good many had been lost or thrown out with the wood on which she had been feeding before the eggs were recognized.

The life period of these beetles is evidently considerable. The two imported ones which survived the winter were active and vigorous until about the end of May, when they perished, the supposed male preceding the female by about a week or ten days. They, in other words, had been kept in captivity for nearly a year, having been collected early in September. This would indicate a life period of at least twelve months, because they were necessarily more than a month

old from the egg when captured, and their lives were probably shortened by the unusual conditions and experiences to which they were subjected. This long life is of very considerable importance in considering the value of these insects as exterminators of the San Jose scale. Their fecundity is also considerable, as indicated by the actual securing of some 200 eggs from an imported specimen and under unfavorable conditions, not counting the loss of a good many eggs. It is not improbable, therefore, that a single female may be the parent of at least 500 young, and the period of usefulness of an individual may extend over twelve months.

The egg is normally concealed under an adult female scale. In other words, the beetle selects a suitable scale, drags out the female scale insect, and either eats it while ovipositing or drops it, turns about and thrusts the ovipositor under the slightly lifted edge of the scale, and in two or more minutes deposits a single egg. This habit of oviposition seems to be peculiar to this species. It was found later on, when the beetles became more numerous, and especially during the period when the old female San Jose scales were not so abundant, and the trees were covered with young scale insects, that other locations would be chosen by the beetle for oviposition, namely, under the loose edge of bark or like situation, or more rarely eggs would be deposited exposed on the bark.

Later in the summer other large cages were built over some pear trees infested with San Jose scale. In all five such cages were built, each of the four later ones including two pear trees about ten years of age but cut back to small size. In these cages the beetles throve wonderfully well. One cage in which two individuals, a male and a female, were placed in May, was swarming with beetles by the middle of July, and more than 100 beetles were taken from it for distribution elsewhere without greatly lessening the stock.

The multiplication of the beetles at this stage was fairly satisfactory, not so much so, however, as it should have been if the experiment had not been interfered with by the presence of certain predaceous insects to be considered later, notably the wheel bug, two species of praying Mantis, lace-winged fly larva, and the larva of *Adalia bipunctata*, it being almost impossible to free these rather large cages from all of these insects. In spite of all the drawbacks, however, the beetles have multiplied to exceed 500 specimens, perhaps 1,000, by the 1st of July from the single overwintered pair, but one of which was presumably a female.

We are making arrangements to ship these beetles to the entomologists and State experiment stations this summer and fall, and we hope to establish this ladybird in the eastern United States. It feeds voraciously on the San Jose scale and on the Diaspis. The larvæ are eating all the time, and the rate of multiplication is such that five annual

broods may be counted on, the third brood in our own breeding cages being under way in the latter part of June. Whether this ladybird enemy of the San Jose scale will really amount to anything as an efficient means of controlling this pest remains to be demonstrated. The San Jose scale is its normal and natural food. It multiplies rapidly, and a larval Chilocorus destroys an enormous number of young scale larvæ in a day, by actual count 1,500 per day or about one a minute, but while actively feeding at the rate of 5 or 6 a minute. The main question to be decided is whether this insect can be successfully established in this country, and if so, whether our native predaceous insects will allow it to yield the full benefit which it should give in keeping down the San Jose scale. We make no extravagant claims, but believe that the experiment is well worth trying, whatever may be the outcome.[a]

It has been suggested that this ladybird is the same as our native species, *Chilocorus bivulnerus*, and, in fact, the superficial resemblance of the adults of the two species is so close that the greatest difficulty will be found in distinguishing them. The larvæ of the two species, however, are distinctly different in general appearance. The Asiatic has the skin of a reddish or flesh tint, the spines being black but less prominent than in our native species. The skin of our native species is a dull gray, and the general appearance of the larva, therefore, is decidedly black or dark, whereas the imported species, when full fed, is reddish. Furthermore, there are structural differences in the spines and hairs which will enable one readily to separate them irrespective of the difference in appearance, which is very striking. The beetles also can be separated, as I am assured by Mr. E. A. Schwarz, although careful anatomical and structural studies have not been made at this writing. The imported species is notably smaller on the average than our native species, and rather more brilliantly colored, and differs a little perhaps in the general shape or convexity of the wings and thorax. Furthermore, it feeds on the San José scale and the Diaspis naturally and normally. Our species, while it is often found in scale-infested orchards in the East, has never done very much good in the orchards, and does not feed and multiply on the scale in the way that it ought. For example, in the grounds of the Department of Agriculture this year we have a little orchard of pear trees thickly infested with the San José scale—the orchard in which we are establishing this foreign ladybird—and yet in all the time during the spring and early

[a] It may be added to the above that during the balance of the summer this beetle did very well in the little Department grove. About a thousand beetles were distributed to various entomologists, from some of whom reports of considerable success have already been received. In Washington breeding seemed to stop toward the end of September, but we now have more than 2,000 beetles which will be overwintered Next year we should have them in quantities for general distribution.

summer of this year that this orchard has been under constant and careful observation but one or two beetles of our native species have appeared, and but two of its larvæ have been seen on the trees. Yet within a stone's throw of this orchard is a tree on the grounds of the Department infested with *A. ancylus*, and on this tree, infested with a native scale insect, the *Chilocorus bivulnerus* has established itself in considerable numbers, probably several hundred larvæ being present on the tree. The history of this ladybird in the East, and as further illustrated by the instance just mentioned, seems to indicate that it prefers our native scale insects and has not yet fully accustomed itself to the San José scale nor to the recently introduced *Diaspis pentagona*. It may take hold of these new scale insects in the course of years, but it certainly does not do so at present in a manner to be of any great assistance in keeping them in check.[a] In Florida and California especially on Citrus trees it is very abundant, as a rule, and an efficient enemy of scale insects. The imported species feeds normally and voraciously on the San José scale and Diaspis, and, if it survives our climate and can be established, we may hope that it will accomplish for us some, at least, of the good results which it was seen to achieve generally for China and Japan.

In the matter of climate, it may be said that the region in which it occured in China and Japan will duplicate nearly enough the eastern United States or California. We have about the same summer and winter temperature and similar general conditions of rainfall and other climatic features, so that from this point of view there seems to be no reason why the imported ladybird should not do well.

That this ladybird or any other parasitic or predaceous insect will ever completely subdue the San José scale in the United States is very problematical, and there is very little doubt but that in future, as in the past, to free an orchard from this scale pest it will be necessary to take the direct and active means now being employed, such as the use of oil, or the lime, sulphur, and salt wash, or other remedies which experience shall demonstrate to be effective. What parasites or predaceous enemies may do is to keep this scale in check so that it will not be so generally abundant and destructive, and especially to keep it down in the thousands of small orchards and gardens where direct spraying operations would not often be undertaken by the owners.

In particular districts it may even put a complete check on the San Jose scale for one or several years. That this is possible is indicated

[a] Toward the end of July some 26 specimens of the native *Chilocorus bivulnerus* were caged over a San Jose scale-infested pear tree to make comparative studies of the life history and habits of the species. Unfortunately, however, all of these beetles perished, without our securing either eggs or larvæ. This rather astonishing and unexpected outcome seemed to be due to a distinct disinclination on the part of these beetles to eat the San Jose scale except in the most sparing manner.

by present conditions in portions of California. Mr. Craw reports in a recent letter that the San Jose scale is now exterminated in Santa Clara County, Cal., where it first appeared in this country.

PREDATORY INSECTS WHICH AFFECT THE USEFULNESS OF SCALE-FEEDING COCCINELLIDÆ.

By C. L. Marlatt, *Washington, D. C.*

When the breeding experiments out of doors were commenced with the imported Asiatic ladybird (*Chilocorus similis*), fears were early aroused for the success of the experiment on account of the abundance of predaceous insects[a] in the small grove of pear, plum, and peach trees attached to the insectary of the Department, which it was proposed to use as a breeding ground, inasmuch as it was thickly stocked with San Jose scale.

A great many egg clusters of the wheel bug (*Prionidus cristatus*) and egg masses of our native praying mantis (*Mantis carolina*) were found attached to the trunks and limbs of these trees. Furthermore, a large lot of the egg masses of the European praying mantis (*Mantis religiosa*) had been shipped to us by Mr. Slingerland of Cornell, and these had been placed in an open cage in the midst of this grove, so that the young could escape. The hatching of these egg masses had already begun. Later developments established the fact that both the wheel bug and these two species of praying mantis would feed on the larvæ of Chilocorus and other ladybirds. In addition to this, as the season advanced, the larvæ of the plant-lice-feeding ladybird, *Adalia bipunctata*, were also found to eat the larvæ of Chilocorus when their normal food was not readily available.

The larvæ of the lace-winged fly (*Chrysopa* sp.) preyed more or less upon the Chilocorus larvæ in the breeding cages, eggs of the former insect being deposited on the outside of the wires in bunches in several instances, and the larvæ entering in some numbers. Perhaps some of the parent insects also hatched directly in the cage. A very careful search of the cage had to be made for these Chrysopa larvæ, and a great many of them were destroyed. Comparatively few were found in the grove, and at least they were not numerous enough to occasion any serious alarm.

The chief difficulty in the cage, however, arose from the presence of the *Adalia bipunctata*. This ladybird multiplies with astonishing rapidity, its eggs being laid in masses, and day after day 50 or 100 of its larvæ and pupæ were destroyed in this cage, and it was two or three weeks before a final clearance was effected. The cage tree was a fairly good-sized plum tree, and it seemed almost impossible to dis-

[a] Relating to bird enemies of Chilocorus, I am assured by Messrs. Beal and Judd, experts on the food of birds, that Coccinellids are rarely found in bird stomachs, even in California, where such insects are very abundant.