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THE IMPORTATION OF TETRASTICHUS XANTHOMELAENAE (ROND.)

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The imported elm leaf-beetle (*Galerucella luteola*), first appeared in this country about 1837 at Baltimore, and has spread to the northeast above Boston and south into North Carolina. It has within comparatively recent years crossed the Appalachian chain of mountains and has begun to spread throughout the Middle West. It has practically no effective American natural enemies, and has increased and spread unchecked, except for such work as has been done by cities and towns and except for unfavorable climatic conditions. In Europe there exist one or more egg-parasites of this and congeneric hosts. In 1832 Boyer de Fonscolombe described one of these egg-parasites as *Pteromalus gallerucae*. In 1898 Kawall described *Pteromalus ooctonus* from the eggs of *Galerucella viburni*. In 1877 Rondani described *Oomyzus xanthomelaenae*. With the possible synonymy of these forms we have nothing to do.

In 1905 Dr. Paul Marchal published in the Bulletin de la Société Entomologique de France for February 22 a paper entitled "Observations Biologiques sur un Parasite de la Galéruque de l'Orme," to which he gave the name *Tetrastichus xanthomelaenae* (Rond.). In this very interesting article Doctor Marchal called attention to the fact that the elm leaf-beetle had multiplied for several years in a disastrous way about Paris, skeletonizing the leaves in the parks and along the avenues in much the same way as is so familiar to the residents of cities in the eastern United States. But with 1904 the ravages apparently stopped, and Marchal's observations indicated that this was largely if not entirely due to the work of this egg-parasite.

During June, 1904, he studied the habits of the species at Fontenay-aux-Roses, his suburban home just outside of Paris. His observations as published in the Bulletin are extremely interesting, and roughly translated are as follows:

"On the 26th of June, at Fontenay-aux-Roses, I collected some elm leaves that had been attacked by the beetle. Most of the eggs found on the surface of these leaves had long since hatched, and the larvae coming from them, in different degrees of development, were eating the parenchyma of the leaves. However, in spite of the late period, a good many eggs were yet unhatched, and among these there were certain ones which were gray in color, due to the presence of the little Chalcidid already formed and ready to issue.

"On the 28th these parasites came out in a receptacle in which the leaves had been enclosed. On the 29th and 30th I watched the ovipositing of the Chalcidid in some groups of elm-leaf beetle eggs that had not hatched and which were behind the great majority. Through the glass receptacle one could see the minute Hymenoptera stand for long periods upon the eggs of the beetle, and to observe a single individual it was quite possible, with the aid of forceps, to withdraw the leaf upon which it was placed and to examine it with a hand lens at leisure.

"In order to be perfectly exact, I will select an individual among those which I have reared, and will relate in succession all of its acts in accordance with notes taken in the course of my observation.

"The *Tetrastichus* is standing upon the summit of the egg of the *Galerucella*, a little to one side and in an almost vertical attitude; its abdomen is incurved. With the terminal pieces of the sheath, which emerge toward the point, it touches and marks the place where the ovipositor is to be introduced; the point of this, which issues from the ventral face, is placed just at the point indicated; then the extremity of the abdomen is lifted, and one then sees the piercing organ, which presents the aspect of a long, fine thread, penetrate, being directed a little obliquely toward the base of the egg. The operation is quite long, and lasts more than a minute. The insect raises and lowers its perforating apparatus several times without entirely withdrawing it from the egg, in which it remains inserted. It appears finally to penetrate quite to the bottom, and then, having remained some instants with its abdomen in contact with the egg, it withdraws the ovipositor. It then begins one of the most curious manœuvres, which makes the biological history of this insect quite original. As soon as the ovipositor is withdrawn, the parasite places its head at the point where the piercing organ has just been, and then licks with avidity the little wound which has just been made. Then it turns around and carries the extremity of the abdomen close to the wound. Then, with the terminal pieces of the ovipositor sheath, it feverishly gropes about, lowering them and raising them, and placing them here and there, until they place themselves exactly at the point of perforation. These movements are quite long, but as soon as the point is found the ovipositor penetrates a second time into the orifice, and remains there about half a minute. Then the insect withdraws it and, by a manœuver like that already described, licks the wound once more with avidity.

"The parasite then rests for some instants, and walks about the leaf in the neighborhood of the beetle eggs; but it returns rapidly to the egg which has

just been left and which it recognizes from all the others. It touches it with its palpi, makes an attempt, which does not seem to be entirely successful, to insert its ovipositor, and once more licks the wound. Then there is another and short walk in the vicinity, followed by a new visit to the same egg. This time the *Tetrastichus* inserts its ovipositor at exactly the same point that it did the two preceding times, holding it inserted about a minute. Then it is withdrawn, and the parasite licks the wound again in a very lively way. After this, without other interruptions than those of preliminary feeling and that of consecutive licking, it thrusts its ovipositor twenty times in succession into the egg. If we add the three preceding times, we reach the result that during the forty-five minutes that the observation lasted, the parasite thrust its ovipositor twenty-three times into the same egg of the beetle. All of the insertions were not identical, and the later ones, in a general way, were much more rapid than the earlier ones. About the middle of the series they lasted from a third of a minute to a half a minute; towards the end the insect took time only to insert the piercer and to withdraw it. The method, however, was the same in all cases, and always was accompanied by the preliminary feeling about and the licking of the place.

"The next day the egg which had been stung by the *Tetrastichus* was examined. It presented, near each other, four minute brownish spots, corresponding to the wounds made by the ovipositor. The insect, in order to avoid unnecessary trouble in searching again for the wound which it had previously made, occasionally made a new perforation when it could not find the old opening quickly enough.

"What can be the reason for this singular manœuvre of the *Tetrastichus*? It is evident that the insect finds in the egg of the *Galerucella* a food which it likes, and that, using its ovipositor in another way than that which is habitually done with these Hymenoptera, it employs it as we use a pin to pierce the shell of an egg in order to suck its contents. If the wound which has just been made is too small to be found readily, it can be noticed that the place licked by the parasite is moist with the liquid which comes from the interior of the egg; often a real drop appears at the surface of the egg and is rapidly sucked up by the parasite.

"It cannot be doubted that one of the motives of the insect in giving its blows with the ovipositor is from its individual interest, but it is not less certain, on the other hand, as the fact even of its parasitism proves, that the *Tetrastichus*, conformably to the instinct of other Chalcididæ, uses its ovipositor to introduce its egg into the egg of the beetle. It seems that among all of the thrusts of the ovipositor which it gives, there can be only a small number intended for egg-laying. In opening the eggs of the egg groups most visited by the *Tetrastichus* I have discovered only a very limited number of eggs belonging to the parasite; but its ovoid, slightly incurved egg, about .023 mm. long, is relatively easy to discover, and it seems very certain that the number of eggs deposited is very far from being equal, to the number of thrusts of the ovipositor. One can even suggest, in a general way, that the parasite does not place more than one egg in the egg of the beetle. On the other hand, one can open the egg of a beetle which has received a number of thrusts of the ovipositor without finding in its interior a single egg of the parasite.¹ And it seems to be a fact that in certain cases the *Tetrastichus* pierces the egg of the *Galerucella* exclusively to nourish itself.

¹This was the case with the egg which has just been mentioned."

"My observations have not been sufficiently complete so that I can state that the egg-laying puncture is made in a different way from that just described, and that, for example, the numerous thrusts of the piercing organ may not be intended to disarrange the contents and to arrest the embryonic development.¹

"If I can get sufficient material, it appears to me that it would be quite possible this year, by commencing to make these observations at an earlier date, to learn more accurately the history of the curious phenomena which accompany the egg laying of this species. I shall hope to find out also how the other generations go on and in what condition and in what stage the *Tetrastichus* passes the winter, and whether it can attack other eggs than those of the elm leaf-beetle."

Visiting Doctor Marchal in June, 1905, after the publication of this interesting article, the writer asked him whether he had been able to make his further observations, and he replied that the elm leaf-beetle had so entirely disappeared in the vicinity of Paris that he had not been able to do so. The writer urged him to make an effort through his correspondents to secure parasitized eggs of the *Galerucella* for sending to the United States in an effort to introduce and establish this important parasite on this side of the Atlantic. It was considered practically hopeless to attempt the introduction that summer, as the time was so late and it was not then known just in what part of France the elm leaf-beetle could be found abundantly. During 1906 practically the same conditions existed; a locality was found, but the parasites did not seem to be present. In 1907, reaching Paris about the first of May, the writer again reminded Doctor Marchal of his desire to import the parasite into the United States, and, meeting Mr. Charles Debreuil, of Melun, at the residence of the Baron de Guerne, the subject was brought up again, and M. Debreuil later in the season forwarded eggs of *Galerucella* to the United States, which were promptly sent to the parasite laboratory at North Saugus, Mass.; but the time was too late and the parasites had emerged and died.

In April, 1908, the Entomological Society of France was good enough to publish in its Bulletin (No. 7), page 86, a request from the writer that eggs of the elm *Galerucella* should be sent to the United States for the purpose of rearing parasites. This notice brought a speedy and effective response. About the 20th of May, Professor Valéry Mayet, of Montpellier, France, a personal friend of the writer, secured a number of leaves of the European elm carrying egg-masses of the *Galerucella*, placed them in a tight tin box and mailed them to the writer's office in Washington. They were received on

¹"This hypothesis appears to me somewhat probable. The arrest of the embryonic development of the host seems really a condition useful for the evolution of the egg of the parasite, and one of the functions of the multiple thrusts of the ovipositor is rather probably to stop it."

May 28th and at once forwarded to Mr. W. F. Fiske, of the Bureau of Entomology, in charge of the parasite laboratory at Melrose Highlands, Massachusetts. This course was taken since at the time mentioned no localities for the elm leaf-beetle were known in Washington and for the past few years this species has been very destructive in the vicinity of Boston. The package was in some way or another subjected to considerable delay in its transmission from Washington to the laboratory at Melrose Highlands, but it finally arrived there on June 1st—twelve days from the time it started at Montpellier. The

FIG. 7. *Tetrastichus xanthomelaenae* Rondani, adult female, very greatly enlarged; antenna, still more enlarged, at lower left.

early seasonal start was possible for the reason that Montpellier, as is well known, is in the extreme south of France. On opening the box, Mr. Fiske found a considerable number of active adults of the *Tetrastichus*. Most of them were placed in a large jar containing leaves of the elm upon which were newly deposited masses of the eggs of the *Galerucella*. This beetle was very abundant at Melrose at the time, and no difficulty was experienced in getting large quantities of eggs. A few parasites were used in reproduction experiments in small vials and tubes, but these experiments were not successful, since the eggs dried rapidly and the parasites themselves were short-lived in such extreme confinement. The females were at once attracted to the egg-masses, and probable oviposition was noticed within an hour after the receipt of the shipment.

Mr. Fiske was able to confirm most of Doctor Marchal's observations indicated in the translation above, but it appeared to him that the female did not always take as much time as Doctor Marchal's notes would indicate. They were several times noticed feeding upon

the contents of the egg as the contents issued from the wounds made by the ovipositor, and this appears habitual and probably necessary for the continued well-being of the adults. There were probably somewhat more than one hundred adults received in the shipment, and very few emerged from the imported egg-masses after the first day. Several different methods of rearing were tried, but the most successful were in the large jar already mentioned. In this jar adults lived surely for 35 days—a remarkable longevity, indicating that they are probably naturally active and engage in oviposition throughout the egg-laying period of the host.

From Mr. Fiske's notes, the following are quoted:

"On June 1, parasites placed in the jar.

"On June 4 they were still very active, and fresh foliage, with beetle eggs, was added.

"On June 8 another addition of fresh foliage with eggs was made.

"June 11, the parasites, of which the larger part were still alive, were carefully transferred to a fresh jar, with newly gathered egg-masses. The *Tetrastichus* continued active, and were noted ovipositing from day to day.

"June 18, the parasites were still active, and fresh foliage was added.

"June 23 the parasites still living were transferred to a fresh jar. There were at least twenty in all.

"June 26, they were still active, and fresh eggs were added.

"June 29, more fresh eggs were added; a number of the parasites were active and apparently ovipositing.

"July 1, there was still a small number of the parasites living, and these were carefully transferred to a fresh jar.

"July 5, several were noted still active, but after that date none was observed.

"Reproduction occurred in all of the jars above mentioned, though in the last it was very scanty. There is no possibility that any of the parasites noted from time to time were other than the originally imported females (the males died very soon after receipt), and the remarkable longevity of the species may be considered as established. It is reasonable to suppose that they would have lived longer in the open under natural conditions than in confinement.

"Very few observations on the larval habits were made. The first larvae were found on June 9, at which time they were in what appeared to be their second stage. They were, at this time, so small as to be almost invisible to the unassisted eye, and were very active when separated in a drop of water from the surrounding mass of the egg substance in which they were feeding. In this stage they are somewhat remarkable for an armature of minute spines, a row of which borders each of the abdominal segments posteriorly. The last abdominal segment terminates with a somewhat more elaborate arrangement of spines.

"After reaching this stage their growth is very rapid, and in three or four days more, last-stage larvae were found commonly in egg-masses from several

of the reproduction experiments which were conducted in large tubes. The first full-grown larvae were found on the 11th, but it is probable that these were more advanced upon the 9th than those actually observed upon that day.

"Young larvae were found in eggs which contained the beetle embryo sufficiently developed to show traces of the legs and head. Many eggs containing embryos further advanced were examined at the same time, and, though these seemed to be dead as the result of oviposition by the parasite, no parasite larvae could be found. The parasite will oviposit, or appear to oviposit, in eggs containing beetle larvae fully formed, but it is doubtful if, under such circumstances, reproduction ensues.

"In laboratory reproduction it is better not to have the eggs too fresh, as they are much more likely to wither, if kept dry, or mold if kept damp, than eggs several days old. It was first supposed that perfectly fresh eggs would be better. A lot of beetles was confined indoors with elm leaves, and the newly deposited eggs used in reproduction experiments. All of these experiments were failures. In the open, with eggs on living foliage, the results would probably be different.

"Pupae were first noted on the 15th. The distinctive coloration of the parasitized eggs was also noted at this time, and it was found possible to separate those containing parasites by their color alone.

"These parasitized eggs are somewhat suggestive of those containing larvae nearly ready to emerge, but lack the characteristic greenish hue. They are grayish in tint and have a dull, dead appearance. They are frequently somewhat withered, and in the case of those from the reproduction experiments were frequently covered with a scanty growth of mold.

"The first adults of the new generation emerged on June 21, and appeared in considerable numbers on that date. This would indicate a life cycle of 20 days, as it appeared that oviposition began at once upon the receipt of the parasites.

"Later generations developed more quickly. From the jar started on June 11, reproduction was secured on June 29, 18 days later. From the fresh egg-masses placed in the same jar on June 18, reproduction was secured 16 days later, on July 4. From the first lot of fresh eggs placed in the third jar, to which the parasites were transferred on June 23, abundant reproduction was secured on July 8, after but 15 days had elapsed. From the fresh eggs added to this jar on June 26, reproduction was secured on July 11, another fifteen-day period. The last jar, to which the parasites were transferred on July 1, contained, on July 15, adults in very small numbers, of what must be their progeny, indicating a life cycle of but 14 days.

"This gradual reduction in the length of the life cycle as the season advanced is peculiar, and no explanation is offered. The average temperature during the latter part of June and first of July was higher than during early June, but there hardly seems to be enough difference to account for six days shortening of the life cycle of an insect which develops as rapidly as *Tetrastichus*."

The adult parasites secured by laboratory reproduction were liberated in two localities near Boston, and parasitized eggs were sent to Prof. J. B. Smith at New Brunswick, New Jersey, and to Prof. M. V. Slingerland at Ithaca, New York, and the remainder were sent to

Washington, since about the middle of July considerable damage by the elm leaf-beetle was noticed in the latter city on certain streets.

The first of the Massachusetts colonies consisted of about 600 parasites, enclosed in an open tube and tied to a tree in Harvard Yard, Cambridge, on June 22d. Mr. Fiske thinks that more than a hundred adults found their freedom on the day of liberation and almost certainly the full 600 within a week thereafter. Fresh eggs were abundant upon the trees for some time thereafter, and the outlook there is very hopeful.

Writing on July 29, Mr. Fiske states that he has found eggs of the *Galerucella* nearly a quarter of a mile from the site of the colony, and that these appeared to be parasitized.

At Melrose Highlands, Mass., more than 1,200 adults were liberated between the 21st of June and the 8th of July, and unhatched eggs were noticed on to the end of July.

The eggs sent to Dr. John B. Smith reached him in good condition and a number of the parasites had already issued on the journey. They were very lively and he liberated them upon a small elm that had some egg clusters and is so situated that he will be able to watch it without difficulty during the summer of 1909. There are also plenty of large trees nearby, so that there will be no difficulty in the parasites flying from one tree to another. The number of parasites Doctor Smith considered to be too few to risk dividing them up.

From the material sent to Prof. Slingerland, at Ithaca, only a few adults issued, and before fresh eggs could be found these had died.

The parasitized egg masses received in Washington were taken to Dupont Circle, and the leaves upon which they were deposited were tied among the branches of the first elm on the north side of New Hampshire Avenue south of the Circle, and the fourth elm on the south side of the avenue. Native eggs were abundant.

So much for the introduction and rearing of a complete laboratory generation, and for the colonization of the species. As to the establishment of the species, there is one note to add. A small lot of fresh eggs collected in the vicinity of the Melrose field colony by Mr. Fiske produced a number of parasites on the morning of July 27. In consideration of the small number of eggs collected, it seems practically certain that there must have been a very abundant natural reproduction of the parasites, and the probabilities are that the species at this date of writing exists in thousands at Melrose. The writer has every hope that the species will pass the winter successfully, and that the eggs laid next summer will be abundantly parasitized in the natural way.

The importance of this importation will be readily understood by all entomologists as well as by all shade-tree lovers, and it is an interesting example of what may be done in this way. The thanks of all good Americans are due to Doctor Marchal, Monsieur Debreuil, and Professor Valéry Mayet for their assistance in this important work.

THE INTRODUCTION OF IRIDOMYRMEX HUMILIS (MAYR) INTO NEW ORLEANS

By E. FOSTER, *Vice-President Louisiana Society of Naturalists*

The exact period of the introduction of the ant *Iridomyrmex humilis* (Mayr) into New Orleans must necessarily remain somewhat of a mystery. The source from whence it came has been also the cause of some dispute among the citizens. On more than one occasion it has been advocated that the insect was introduced during the time of the Cotton Centennial Exposition, held in Audubon Park during 1884 and 1885, and only quite recently I have seen the view expressed in the public press that it first invaded the port by way of the Algiers and Gretna, or west side of the Mississippi River. For these theories there is, in my opinion, little foundation.

Prof. Wilmon Newell has named this pestiferous insect the "Argentine Ant," from the fact that it was first described from specimens collected during 1866 in the neighborhood of Buenos Ayres. Against the adoption of this proposed popular name there can be no objection, although the insect is well-known in Brazil, and from the fact that all evidence point to this latter country as the native habitat of the first individual, or batch of individuals to land on our wharves, it might more appropriately have been named after the "place where the nuts come from."

New Orleans has had no direct commercial intercourse with the Argentine Republic; at least, in the form in which such an insect would be likely to be introduced. In the case of Brazil, however, it is quite a different matter, for cargoes of coffee have been coming to New Orleans almost since the date of the Louisiana Purchase, and certainly since the passage of the Compromise Act of 1833, when the abolition of the duty gave a great impetus to importations. But it is needless to speculate as to whether the ant landed on the wharves as far back as that date, and, moreover, my days have not been "long enough in the land" to hark back for the better part of a century.

It is an axiom that an insect pest visitation starts somewhat like a fire which, if not quenched in the incipient stage, spreads rapidly once