

ECOLOGICAL OBSERVATIONS UPON THE MYRME-
COCOLES OF *FORMICA ULKEI* EMERY, ES-
PECIALLY *LEPTINUS TESTACEUS*
MUELLER¹

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In the autumn of 1928 certain observations were made upon the blind beetle, *Leptinus testaceus* Müll. in the Chicago area, which was found associated with other species of Coleoptera in the nests of the mound-building ant, *Formica ulkei* Emery. Some of these data are presented at this time.

The Ecological Status of *Leptinus testaceus*.

Leng (1920) gives the general distribution of this species as Europe, Iowa, Ohio, Pennsylvania, District of Columbia, and British Columbia, and Brendel (1887) lists *testaceus* from the vicinity of Peoria, Illinois. Its presence in the Chicago area is attested to by only two previous records, e.g., Longley (1905) found a solitary specimen in a mouse nest at Clarke, Indiana, and Blatchley (1910) records the species from Lake County, Indiana, finding it from March 11 to December 1, when it probably hibernates in the imaginal state.

This leptinid apparently has a wide range of hosts, being found upon, or in the nest of, wood-mice, field-mice, moles,

¹The term "Myrmecocoles" is used here, rather than "Myrmecophiles", not as an additional burden to the terminology. The usage of the former is broader, embracing all of those species occurring in the nests of ants, and less definite, since the degree of association between occupant and host is not known with exactness in many instances, and consequently reserves for the latter term species where an intimate relationship is known to exist.

shrews, rats and small mammals in general, especially the rodents and insectivores (LeConte, after Brendel, 1866; Riley, 1889; Schwarz, 1890; Dury, 1892; Kellogg, 1914, and Jeannel, 1922); in the nests of birds (Imms, 1924); in the nests of Hymenoptera, viz. Vespidae, *Bombus*, and *Formica* (Jeannel, l.c., and Imms, l.c.). Imms (l.c.) has even mentioned its occurrence in rotton wood, and it was taken under "chalk flints" by Hardy (1848).

The exact relation of this species to its several hosts is not definitely known. Its status has been variously placed as that of an ectoparasite feeding upon the hair or secretions of small host mammals; as that of a scavenger, living on the nest refuse; as a tolerated guest; or as one of those species exhibiting phoresy, and the literature is partially covered and the questions involved discussed by Kellogg, 1914, Rüschkamp, 1914, and Jeannel, 1922. Dury and Blatchley believe this leptinid to be a guest, possibly even feeding upon mites and fleas associated with *testaceus* in mammal nests. The presence of the species in decaying wood may indicate ability to live a more active life, or may be an accidental occurrence. On the other hand, *testaceus* may exhibit phoresy. This uncommon phenomenon has been discussed by a number of investigators, among which may be mentioned the account of Lesne in 1896, Rüschkamp, l.c., Banks, 1911, and Wheeler, 1919.

If *testaceus* exhibits phoresy, the species may live in the nests of bees, feeding upon honey and pollen, and using small mammals, such as field-mice, for transportation from one nest of bees to another. *Testaceus* is well-known as an inhabitant of the nests of bumble-bees, e.g., the work of Gorham in 1869; and Wheeler, 1923, p. 113, says of these bees that their colonies are an annual occurrence. The fecundated queen overwinters and in the spring chooses a small cavity in the ground or in a log, *preferably the abandoned nest of a mouse*, to line with grass or other materials at hand and so start the incipient colony. It is an interesting possibility that *testaceus* may live as a guest in the nests of Hymenoptera, and exhibit phoresy as the occasion arises.

It is even possible that this phoresy, if it exists, is a stage in parasitism and the blind condition of the beetles would

strengthen this view, especially since it has a relative (*Leptinillus validus*) with greatly reduced eyes. Another related species (*Leptinillus aplodontiae*) is said to leave its rodent host when the latter is killed, and as soon as the body begins to cool (Ferris, 1918), which may indicate some degree of parasitic adjustment. All of these leptinids have been shown to be closely related to the beaver parasites, Platypsyllidae, (Horn, 1882; Riley, 1889). However, they are also allied rather closely to the Silphidae morphologically (LeConte and Horn, 1883; Sharp and Muir, 1912; Imms, loc. cit.), a family which numbers scavengers, as well as saprovores and carnivores.

The various views that have been held are not necessarily mutually exclusive, and it is possible that the Leptinidae exhibit a facultative parasitism which would explain many of the differing accounts in the literature, and bring into agreement the finding of *testaceus* in habitats suggesting phoresy, a guest relationship, an actual ectoparasitism, a scavenger existence, or a chance occurrence.

Leptinus testaceus and other Coleoptera in nests of
Formica ulkei.

On October 6, 1928, a trip was made to Palos Park, Illinois in search of Pselaphidae. Palos is some thirty miles south-west of Chicago in the glaciated section of the Chicago area and is characterized by an oak, elm, hickory subclimax forest in the upland forest sere of this area (Park, 1929 a, b). A portion of the Palos sector is inhabited by the mound-building ant, *Formica ulkei* Emery. The *ulkei* community is rather extensive, especially in the more open clearings of the forest and along the forest margins. The ant has been little studied in nature (Wheeler, 1926). Burrill and Smith (1918) record the species from Cedarsburg, Wisconsin, and in a later paper (1919) mention the finding of a larva of the chrysomelid, *Coscinoptera dominicana* (Fab.) in an *ulkei* nest. Recently, Holmquist (1926, 1928 a, b) has given the most complete account of this ant in the Chicago area, and a note upon a guest ant associated with

ulkei colonies at Palos has been published (Park, Thomas, 1929).

Formica ulkei colonies are also established at Palatine, Illinois, some thirty miles north-west of Chicago under the same general ecological conditions. The Palatine colonies have not been as thoroughly studied for myrmecocoles as those at Palos, this latter section having been visited repeatedly.

A number of species of insects have been taken from the *ulkei* colonies. These species have been determined as follows,¹ and the locality records given in order to supplement as much as possible the account of Holmquist (1928 a, pp. 83-4) :

TABLE I. Myrmecocoles of *Formica ulkei* Emery.

HOMOPTERA

Cicadellidae

1. A nymph taken at Palos, August 4, 1929, in the lower dome galleries.

NEUROPTERA

2. A neuropterous larva, very similar to the larvae of the Chrysopidae, taken in a lower gallery at Palos, August 4, 1929. It may have been brought in by the ants, or it may have wandered in, either by chance or to feed upon aphids.

DIPTERA

Syrphidae

3. *Microdon*, sp. The larvae of *Microdon* were usually present in the nest, both in Palatine and at Palos, and were present in certain nests in great abundance on October 6, 1928, at Palos, especially in the less superficial galleries.

¹I am greatly in debt to my friends, Mr. W. J. Gerhard and Mr. Emil Liljebblad, of the Field Museum of Natural History, for their care in determining and rechecking the material collected from the *ulkei* nests.

COLEOPTERA

Carabidae

4. *Tachyura incurva* (Say) Abundant. Palos: October 6 and 13, 1928; April 4 and 12, August 9 and 16, 1929. Palatine: August 6, 1929. It is interesting to note that this species has also been taken in the nests of the related host, *Formica exsectoides* (Ulke, 1890; Schwarz, 1890).
5. Two small carabid larvae were taken from the lower dome galleries, one at Palos (August 16, 1929) and one at Palatine (August 6, 1929).

Staphylinidae

6. *Megastilicus formicarius* Casey. Palos: August 4, 1929. It is interesting to note a further parallel in the myrmecocoles of *ulkei* and *exsectoides*, this staphylinid being reported from nests of the latter by Schwarz (1889).
7. *Atheta polita* Melsh. This species of the Myrmedoniini was abundant on October 6, 1928, in the dome galleries and entrances of a weak colony at Palos. This species has also been recorded from the galleries of *Reticulitermes flavipes* by Park (1929 c), and Ulke (1890) mentioned finding staphylinids allied to *Myrmedonia* in numbers in the nest of a species of *Formica*.

Leptinidæ

8. *Leptinus testaceus* Müll. Abundant in a weak colony of *ulkei* at Palos, October 6, 1928.

Pselaphndæ

9. *Batrisodes globosus* (Lec.) October 6 and 13, 1928, at Palos. In numbers on the former date.
10. *B. denticollis* Casey. Abundant at Palos on October 6, 1928; April 4 and 12, and August 4, 1929.
11. *B. species*. Palos on October 6, 1928.

Cucujidæ

12. *Cathartus advena* (Waltl.) At Palos on October 6, 1928. Possibly a chance occurrence or had penetrated the colony for hibernation.

Elateridæ

13. *Melanotus communis* (Gyll.) A single adult which was still very soft and pale from pupation, taken from a nest at Palatine on August 6, 1929.

Scarabæidæ

14. *Phyllophaga* species. Larvae, pupae and imagos taken from the Palos nests on October 6, 1928. Rather abundant.
15. *P. horni* Smith. One male. In lower dome galleries as above.

On October 6, 1928, thirteen *Leptinus testaceus* Müll. were taken from the upper galleries of a weak colony of *Formica ulkei* Emery. The mound was beginning to be overgrown with grasses and measured only eight inches high and some two feet in diameter. With the leptinids were taken fifty-six *Batrissodes* and twenty *Tachyura*.

Since *testaceus* is exceptional in the mounds of ants and is not reported from those of *ulkei*, it was sought repeatedly but others were not seen. The original lot was carried to the laboratory with other myrmecocoles for study, and the following points were learned as to the ecology of these species:

ENEMIES

Leptinus testaceus Müll. was isolated in a petri dish nest and thirteen workers, both major and minor, of *Formica ulkei* were introduced. This group was maintained for six days, the ants being fed on sugar water. During this time the beetles were not molested by the worker ants. The latter passed near or over the leptinids frequently without being visibly stimulated beyond a momentary pause in their walk, or an occasional investigatory movement of their antennae.

Conversely, when a *Leptinus* came into contact with an *ulkei* worker it usually crouched to the substratum, remaining motionless, and seldom ran away.

Similarly, the leptinids were apparently not molested by the pselaphids (*Batrisodes globosus* and *B. denticollis*), and *vice versa*, nor were the pselaphids attacked by the ants.

In another series of observations, leptinids were isolated with the carabid, *Tachyura incurva*. In one petri dish, out of three used, the leptinids were unmolested. In the other two nests, each having one *Leptinus* and three *Tachyura*, the *Leptinus* were completely devoured within twenty-four hours save for the meso- and meta-sterna and the elytra. Further details on the carnivorous behavior of these carabids will be given later, however it is interesting to note that when a leptinid was met by *Tachyura* in the laboratory nests it frequently darted out of the latter's path.

FOOD

Just what the food of *testaceus* consists of has been generally guessed at and in view of the controversial nature of its status with its many hosts, some knowledge of its feeding habits should be of interest.

A simple leptinid was placed in each of six petri dish nests and given no food by the experimenter for two days. Obviously, during this time it may very well have caught and devoured small organisms in the soil taken from the *ulkei* nests placed in the dishes, which could not be readily removed, e.g., small acarinids (Gamasoidea?).

At the end of two days, viz., the second night, a depressed slide full of sugar syrup was placed in each dish. Two of the leptinids were observed to halt at the slide. These two lowered the head and prothorax and after tapping about with their antennae, moistened their palpaе and mandibles in the solution. The other two either went around the syrup, or turned back on their path. It is possible then, that *testaceus* will feed on occasion on sugar syrup. Mere moisture was certainly not at a premium in the petri nests as one section of the soil was kept saturated with water.

Formica ulkei workers, it may be added, readily took up the sugar syrup and subsequently could be seen regurgitating to other workers. The pselaphids, *Batrisodes*, were not observed to feed on the sugar solution and often walked through, or were caught in, the syrup without being seen to take any with their mouth parts.

In view of these data, it is possible that *testaceus*, under the proper conditions, feeds on the honey in the nests of bumble-bees, and since its food habits are compatible with this view, it may exhibit phoresy, being carried about by mammals from one nest of bees to another, and consequently being taken in their nests as well. This is not to say that *testaceus* could not exhibit carnivorous or omnivorous behavior, nor that it could not live as both an ectoparasite and a guest, under suitable conditions.

The occurrence of *Tachyura incurva* (Say) in the nests of ants, especially *Formica exsectoides*, a host ant related rather closely to *F. ulkei*, has been noted by Ulke (1890), and Schwarz (1890), and its general distribution under bark and on the floor of forests is commented upon later. Despite the abundance of this species, little is known of its behavior.

Incurva apparently shows some periodicity in its appearance with *Formica ulkei*, thus some days (August 9, 1929) it was present in great numbers, several to a square foot of nest surface, running about over the surface of the mound, in the grass on the moist soil around the nest, and coming in and out of the gallery openings with the *ulkei* workers, especially the openings near the base of the dome of the nest. On this date it was also present in numbers within the nest itself, at the ground level and the intervening galleries to the most superficial ones. On other days (August 16, 1929) it was almost absent, several being taken from three nests. Again, the species would appear to frequent some nests rather than others in common with *Batrisodes* and other myrmecocoles. Thus one nest would yield a number of the carabids while adjacent nests would be almost devoid of myrmecocoles. I have found *incurva* to be the most abundant beetle myrmecocole of *ulkei* at Palos,

as well as at Palatine on August 6, the only trip made to the latter locality.

This carabid appears to occupy a most fortunate position in the *ulkei* community. It is practically unmolested by the worker ants at all times, as mentioned before the beetles running in and out of the galleries at will, undisturbed by the ants, and occasionally becoming motionless when an ant passes them. The carabids were killed on several occasions and placed on the surface of the mounds at Palos Park, and the worker ants did not molest the beetles very much more when dead than when alive. Thus, although the *ulkei* were bringing in all sorts of insects, dead or alive, for consumption, the dead *Tachyura* would often be passed by a worker, occasionally investigated, and rarely picked up. In the latter case, the worker would shortly drop the beetle and walk away. This was also observed in laboratory nests of *ulkei*.

On the other hand the larvae (Carabidae?) taken at Palos and at Palatine, when placed with *ulkei* workers, were pursued and one was devoured by the ants.

Observation of *Tachyura* shows that, although unmolested by the other members of the *ulkei* community so far observed, the carabids prey at will on anything they can devour. In this they resemble the behavior of the hyaena, only attacking when their prey is dead or sufficiently disabled to be harmless, as the following points will indicate.

In the first place, these carabids are essentially cannibalistic, and given a dead or disabled *incurva*, it is seized by others if they are within a sufficiently short distance to be stimulated by the food. Apparently the beetles must be within several millimeters before the presence of food stimulates them, and if the latter is removed a short distance away they have difficulty in again locating it. If one of the beetles finds the food it seizes it in its mandibles and quickly hides with the morsel where it can devour it unmolested. If two or more of the beetles find the food at the same time, or discover one feeding, they immediately attempt to take the morsel away, and tug and pull the food about until each obtains a portion, or one manages to run away with the whole, of their dead comrade. Such behavior is only shown in the presence of food apparently, as the

species can be kept in confined quarters in great numbers and the individuals will not fight or molest one another as long as they are in good condition.

If the food is too heavy to be taken away, the *incurva* feed on the prey *in situ*. Where possible pieces are pulled off and these are taken off and surreptitiously eaten, upon which the beetle returns again for another morsel. Thus it is a common sight to the experimenter to see six to ten *incurva* tugging and biting at such large prey as the larger Muscidae (*Lucilia*, *Calliphora*), feeding on the fly, with the beetles distributed in a circle about the victim, each beetle with a certain section of the carcass. Under these conditions when a beetle leaves its place and attempts to dislodge a neighbor, the latter bites at the intruder and usually drives it away.

The *incurva* usually attack the mouth-parts of their prey first (Fig. 1) and these are sucked or licked for the moisture obtained. Before attacking such a fly, the beetle will often circle it several times, biting at the sclerites and wings in passing and then invariably settle on the moist mouth region or the membranous joints between segments of the legs and body sclerites. However, if a wound is first made in the fly, this is attacked as readily as the mouth-parts.

Even more readily is a dead or disabled worker of the host ant, *ulkei*, attacked. The behavior is essentially the same, the beetles showing a preference for the mouth parts glistening with regurgitated fluid. If the head of the ant is crushed a drop of fluid is forced on the mouth-parts and this is rapidly devoured by the beetles, often one on one of the ant's mandibles, and a second on the other side of the head, the two biting at each other when they are too close or driving away other beetles from this region. Occasionally the gaster of the ant is licked, possible for the oily secretion, and the antennae and leg joints, or wounds are attacked.

The queens of the guest ant, *Solenopsis molesta*, living with *Formica ulkei*, are attacked by the latter when possible (Park T. Loc. cit.) and *Tachyura* feeds on *molesta* also. Here the *molesta* queen is devoured in the same way

that the *ulkei* workers are, the mouth-parts being most stimulating to the beetles.

Finally, the mouth-parts of *ulkei* workers have been wiped as dry as possible and then covered with a drop of saturated sugar solution. The *incurva* sucked or licked the mouth-parts as dry as though the fluid had been regurgitated by the ant. To see whether or not the laboratory sugar solution would be eaten if given them as such, drops of the fluid were placed on bits of paper or wood, and the *incurva* fought and gathered about these drops until they had eaten all of it, as though the species were accustomed to such a diet in nature.

In addition to this varied diet of *incurva*, the species has also been seen to devour crushed larvae and pupae of the host ant, *Formica ulkei*, and the myrmecocolous staphylinid, *Atheta polita* as well as attack the larvae of the syrphid, *Microdon*, taken from the same host nest, when the latter's soft, ventral creeping surface was exposed.

From such observations one obtains a fragmentary picture of the place held by *Tachyura incurva* in the *ulkei* biocoenose, viz., that of a relatively unmolested species feeding upon the stores of food carried in by the *ulkei* workers, and attacking both the host ants, and the other co-inhabitants of the nest when these are dead or disabled. It is possible, although improbable, that the *incurva* may even creep up and steal some of the regurgitated fluid being given to a worker *ulkei* by another, as is the custom of certain synoeketes (*Atelura formicaria*), although its general habits tend to place the species in the role of scavenger. In return for this abundance of food and protection from the enemies of the carabidae (birds, toads, insectivorous mammals, and predaceous insects in general) which give the *ulkei* mounds a wide berth, the *incurva* perform the doubtful favor of aiding in removing nest refuse, a task which is ably performed by the ants themselves.

RESPONSE TO MOISTURE

Other things being equal, the temperature of the *ulkei* mounds is more constant than that of the surrounding

environment (Holmquist, l. c.) and the galleries run to the superficial water table, and are consequently always moist, even in the hot, dry summer months. In such nests a temperature and a moisture gradient exists and either of these factors, or both, may have important effects upon the behavior of the inhabitants of the *ulkei* nest.

That moisture is important in the life of *testaceus* is shown by the following experiment:

Following the technique of Allee (1926), dry filter paper was cut to fit the bottom of petri dishes and in three such dishes two *testaceus* were placed. The beetles alternately walked, paused or ran about in their characteristic manner described later, for an hour and a half. During this time they were very active, crawling up the sides to the glass roof and then returning to the filter paper. At the end of this time a drop of water was placed on the filter paper at a definite point (A) on one side of each dish. In each dish the beetles located the moistened area within five minutes after its absorption. Once, having traveled through this wet area, they invariably paused, turned back, and after running back and forth in the moist area, each time halting at the periphery of the moistened spot, finally crouched in this spot and remained motionless, the head and antennae resting on the paper.

This motionless state was broken at intervals and the beetles ran about within the spot of moisture, apparently at random but trapped by their physiological requirements in a way suggestive of trapped *Paramecia* in acidulated water as described by Jennings.

As the area "A" became larger, and the surface more and more dry, the leptinids were correspondingly more and more restless, until, with the filter paper with a more or less uniform degree of moisture, the beetles had regained their normal activity and ran restlessly about.

This behavior was repeated at will in two of the three experimental petri dishes, with the same results. In the third the paper was allowed to dry over night by placing it on a table and covering it with the glass top, the glass bottom of the petri dish being removed. The next morning the leptinids were found dead, and strangely enough, in the

area "A", as if these unfortunates had run about until exhausted in the dry atmosphere, and had returned to die in the originally moistened area.

A fourth petri dish, with no filter paper over the bottom, was used as a partial control and the two leptinids therein were normally active throughout the experiment, hiding in the loose soil covering the bottom or walking over the glass sides of the dish. It is doubtful if the presence of the filter paper, rather than moisture, was the cause of the behavior of the experimental animals, especially since in these latter cases, the dry areas of the filter paper acted as a partial control as well as the dish with slightly moistened soil.

The above experiment was repeated with *testaceus* with the same results, and also with *Batrisodes*. In the case of the pselaphids, ten were placed in a petri dish, instead of two leptinids. Random walking about was observed for an hour, and then with the moistening of the filter paper at a definite point as before, the pselaphids soon found this area, and a few minutes later were motionless in the center, viz. the moist wet portion of the filter paper. The large number of the pselaphids made possible the use of larger groups in the experimental dishes, and the beetles were seen to aggregate in the center of the moist area. Usually this place aggregation was motionless, relatively, the beetles resting quietly on the paper, frequently with their legs and antennae touching each other. Such an aggregation reminds one of the bunching of land isopods under similar conditions (Allee, 1926, 1927), and may be partially explained as a contact aggregation in which the limited moistened area and subsequent crowding formed the aggregation. On the other hand, the pselaphids, *Batrisodes globosus* and *denticollis*, may very well exhibit a normal tendency to collect in pockets or portions of galleries of their host's mound. In either case, a relative amount of moisture may be cited as an important stimulus.

As in *testaceus*, the pselaphids, when left over night on the drying filter paper, were found dead the following morning, loosely bunched on the center of the previously moistened section.

Batrissodes were used in a variant of the above experiment. The aggregation was allowed to form on the moistened part, and then additional water was added until this area was saturated. Under these conditions, the beetles became restless, and the aggregation rapidly broke up, indicating that too much moisture is as stimulating as not enough. This last response has been found for similarly induced gatherings of land isopods (Allee, 1926).

Such gatherings upon moistened areas of filter paper, when induced, are not necessarily motionless. At intervals one or more of the aggregants will rise and wander about, to return usually to the crowded section. Even when the group is quiet, individuals frequently tap the paper or one another with their legs or antennae.

RESPONSE TO LIGHT

Petri dishes with a diameter of 14.5 centimeters and a depth of 3.5 centimeters were so covered with light-tight paper that one half of the dish would be in shadow when placed under a 40 Watt Mazda lamp giving approximately 120 foot-candles at 35 centimeters, (measured with a Macbeth illuminometer). The experiments were run at night to avoid light from any other source, and were conducted for six trials of a minute each, with a dark interval of half a minute between trials. The animals were given a one minute adjustment period prior to the first trial of each experiment, as the species used had a tendency to run rapidly about the dish at first. The experiments were short also, to obviate the rise in temperature as much as possible, the latter being fairly constant, running from 28.5 to 30.5° C. for one experiment. The glass top of the petri dish, one half of which was light-tight, was rotated 180° between successive trials to vary the portion of the dish shaded.

Under these conditions, the following results may be mentioned:

1. The carnivorous *Tachyura incurva*, in common with many of the related carabids, was photo-negative under the experiments as described. This may very well indicate a nocturnal active phase, the species being taken through-

out the Chicago area from April to October on the forest floor under leaves, and under bark of logs by day. It is evident, then, that a photo-negative, predaceous carabid should be at home in the dark, moist galleries of *ulkei*.

The degree of positive or negative response to light was calculated in percentage of time the animal spent in the illuminated or darkened portion of the petri dish. Under these conditions, *incurva* was consistently 85 to 90% photo-negative.

2. The pselaphids, *Batrisodes*, were less strongly photo-negative averaging 60% of the time in the darkened area.

3. The blind *Leptinus testaceus* was completely indifferent to the light used, walking about the periphery of the petri dish in a steady movement, half of the time in the shadow, and half of the time in the light, which is in accord with its morphological make-up.

It is clear that light does not play the prominent role that moisture does in these last two species of myrmecocoles.

ACTIVITY

The carabid, *Tachyura incurva*, the pselaphids, *Batrisodes globosus* and *denticollis*, and the leptinid, *Leptinus testaceus*, are as distinct in their locomotion and general activity as they are in morphological habitus. The pselaphids have a rather slow, regular walk, their legs moving in a stiff clock-like precision reminiscent of many Histeridae and the parnoid families, Dryopidae and Elmidae. They are essentially awkward, readily become upset and right themselves with the greatest difficulty.

On the other hand, *Tachyura* is much more active, and rights itself more easily. *Leptinus testaceus*, in consequence of its great width in proportion to its depth of body, loses its balance only rarely and then rights itself with ease. Being so flat it may creep into narrow crevices between particles of soil and hide, as was frequently observed, the general body plan reminding one of the flattened Cucujidae, Nitidulidae, the histerids *Hololepta* and *Platysoma*, the flat bark bugs, Aradidae, the exotic forms, as the carabid,

Mormolyce, and others which live normally beneath bark. The movement of *testaceus* is peculiar. The individuals observed are given to frequent, short pauses in their running, and exhibited an unusually quick change of pace and direction. In consequence of this behavior, their normal gait is a darting movement.

The speed of these three species, and of the host, *Formica ulkei*, may be mentioned as interesting. Individuals were

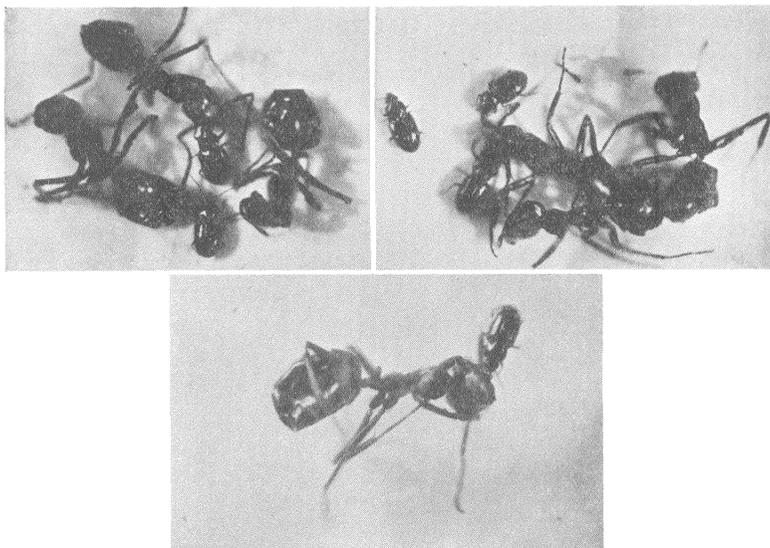


Fig. 1. *Tachyura incurva* (Say) feeding on the host ant, *Formica ulkei* Emery. Photographed from life by Carl Welty.

placed on a wide expanse of concrete floor, their path traced in with chalk and the distance covered in a unit of time taken with a stop watch.

Workers of *Formica ulkei*, and the predator, *Tachyura incurva* are both relatively rapid travelers, moving, when stimulated, between 150 and 200 centimeters per minute. *Ulkei* workers, however, do not hold this speed for repeated trials.

Batrissodes is slower, moving between 65 and 80 centimeters a minute on the average, and *Leptinus testaceus* was found to be the slowest species examined, averaging 30 to 50 centimeters a minute. Usually *testaceus* is more rapid in its running than the pselaphids, attaining a much higher speed than the average cited, but its frequent pauses bring down the average time. When *testaceus* is unduly stimulated, instead of running rapidly away as do the *ulkei* workers and *Tachyura*, it tends to letisimulate. Thus in one series of trials it averaged five periods of death-feigning per minute and covered on the average only 4.2 centimeters. Such behavior, in addition to its hiding proclivity, would indicate that it met danger first by rapid darting, and then finally seeking safety in immobility, with the head and prothorax deflected and the antennae and legs more or less protected by the shield like margins of the body. At least the death feint, so-called, is pronounced in the species when induced by contact stimuli, and the resulting quiet state may be a reflex response. Whether such a condition would prevent its being attacked is problematical.

As would be expected, individual beetles showed individuality in their rate of locomotion, some being consistently faster than others, and one *testaceus* was far more prone to letisimulate than any of the others used.

Similarly, there was a gradual loss of activity in the laboratory animals, their rate of locomotion being much higher when brought in from the nests than several days later.

Despite such complicating factors entering into the question of activity, the species used showed a differential speed of running, and this fact may be significant. Thus these observations make it probable, and indeed rather obvious, that the predatory inhabitants (synecthrans, Wheeler, (1926), by the very conditions of their existence, should be more active, and move faster than the less persecuted synoeketes and symphiles, and the latter slower than the synoeketes. Exceptions of course are to be expected.

SUMMARY

In this paper the term "myrmecocoles" is suggested to cover the organisms found in the nests of ants, irrespective of degree of association with the host ant, viz. accidental occurrence to the symphiles and parasites, and a supplementary list of the myrmecocoles of *Formica ulkei* is given.

Certain ecological interrelationships have been observed among the beetles inhabiting the nests of the mound-building ant, *Formica ulkei* Emery and experiments have been made to determine their general behavior with respect to the biotic factors of enemies and food and the physical factors of light and moisture as well as the differential activity of these species under laboratory conditions. It is suggested that the rate and character of locomotion of certain myrmecocoles may be a partial criterion in determining the degree of association between the species and its host ant.

Especial reference is made to the blind *Leptinus testaceus* Müll. and its behavior as possibly throwing some light upon its ecological status, as well as the carabid, *Tachyura incurva* (Say), and the pselaphids, *Batrisodes globosus* (Lec.) and *B. denticollis* Casey.

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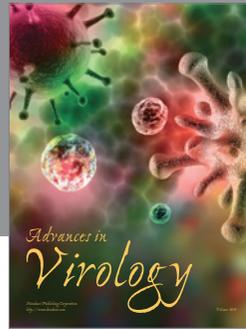
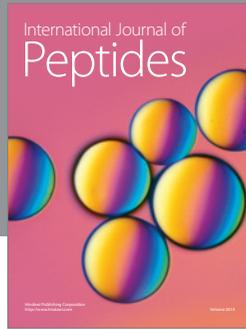
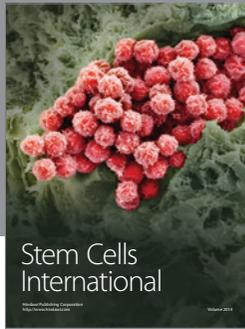
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LEMA PALUSTRIS BLATCHLEY. A nice series of this rather uncommon beetle was taken in Framingham on June 16, 1929, by sweeping the budding plants of the Canada thistle; a week later they had disappeared entirely. Previous to 1913 this species was considered to be *brunnicollis* Lac. which is a more southern species.

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