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No. 1

THE GENUS *NARNIA* STAL, AND A KEY TO THE GENERA OF ANISOSCELINI A. AND S. (COREIDÆ: HETEROPTERA).

BY EDMUND H. GIBSON and ABBY HOLDRIDGE,
Bureau of Entomology, Washington, D. C.

Members of the genus *Narnia* Stal present an interesting group in the tribe Anisoscelini A. and S. as well as presenting difficulties to the systematist. In 1862 Stal described the genus to include his *femorata* and later, in 1870, he described *N. pallidicornis*, both descriptions being made from single specimens. Since then three other well defined species have been added to the genus. Now, from the study of a large series of specimens it appears that Stal's two species are the same and one species, with the name *femorata* retained. The characters which he gives for separating *pallidicornis* from *femorata* can not be termed stable, such as the color of the basal joint of the antennæ, which varies to a considerable degree in nearly every species of the tribe. The late Mr. Otto Heidemann was of the same opinion as the present authors in this matter. Mr. E. P. Van Duzee, *Entomological News*, Vol. XVII, No. 10, pp. 384, 1906, has also voiced a similar belief when he stated that he suspected *femorata* to be a northern form of *pallidicornis*.

Mr. Van Duzee considers his species *snowi* and *wilsoni* as forming a subgenus to which he gives the name *Xerocoris*. In this respect the authors disagree with Mr. Van Duzee and state that if there is to be any dividing of the genus it should be so as to group *femorata* and *snowi* together and *inornata* and *wilsoni* together. Such a grouping would be based upon the form of the dilation of the hind tibiæ which is quite generally accepted to be of greater importance than the relative breadth of insect and connexium, and form of prothorax. It seems quite unnecessary to recognize subgenera in *Narnia*.

Narnia Stal.

Narnia Stal, Stett. Ent. Zeit., Vol. 23, p. 294 (1862).

Head elongate, horizontal. Antennæ rather stout but not swollen or dilated, basal joint short, shorter than length of head; rostrum passing the metasternum, bucculæ short. Thorax longer than head, broad and rounding posteriorly. Elytra narrowing towards apex. Hind femora more or less swollen, hind tibiæ with small dilations or foliations. *Narnia* may be separated from *Leptoglossus* by the smaller dilation of the hind tibiæ and shorter basal joint of antennæ.

Key to the Species.

1. Dilation of hind tibia reaches two-thirds the length of tibia . . . 2
 Dilation of hind tibia reaches three-fourths the length of tibia . . 3
2. Elytra with distinct, broad, white band; width comparatively great *snowi* Van D.
 Elytra without distinct white band, sometimes a slight trace of one; width comparatively narrow *femorata* Stal
3. Species small, apex of head, basal joint of antennæ, and legs red *wilsoni* Van D.
 Species larger, no distinct red colorations *inornata* Dist.

Narnia femorata Stal.

Narnia femorata Stal, Stett. Ent. Zeit., Vol. 23, p. 296 (1862).

Narnia pallidicornis Stal, Enum., I, p. 166 (1870).

This species can be distinguished from all others by the short stout dilation on the hind tibiæ and without band across elytra.

The species occurs in California, Arizona, Texas, Mexico and Guatemala.

Narnia snowi Van D.

Narnia snowi Van Duzee, Ent. News, Vol. XVII, No. 10, p. 384 (1906).

The distinct broad white band across the elytra and broader form will readily distinguish this species from *femorata* Stal.

It is recorded from California, Arizona and New Mexico.

Narnia inornata Dist.

Narnia inornata Distant, Biol. Cent. Amer., Vol. I (1880-93).

This species may be readily distinguished by the long slender dilations of the hind tibiæ, and lack of reddish colorations.

This western species occurs in Arizona, California and Mexico.

***Narnia wilsoni* Van D.**

Narnia wilsoni Van Duzee, Ent. News, Vol. XVII, No. 10, p. 384 (1906).

Wilsoni differs from all other species in that it is much smaller, and has red colorations on apex of head, basal joint of antennæ, and legs.

This species occurs in California.

A Key to the Genera of Anisoscelini A. and S.

The following key includes all of the genera of the tribe Anisoscelini A. and S. Representatives of but three of the genera, *Chondroceræ* Lap., *Leptoglossus* Guer. and *Narnia* Stal occur in American north of Mexico, the other genera being limited to Central and South America.

The tribe may be characterized as follows: Head elongate, antennæ long and more or less slender. Thorax trapezoidal in form, greatly depressed anteriorly, posterior lateral angles more or less acutely angled. Posterior femora sometimes swollen but not incrassated. Posterior tibiæ with a broad thin dilation or foliation which is often wider than the width across the elytra.

The genera may be considered as grouped into two divisions, *Anisoscelaria* n. n. those having the joints of the antennæ simple as in *Anisoscelis* and *Chondroceraria* n. n. those having the joints of the antennæ more or less dilated as in *Chondroceræ*.

The authors feel justified in placing *Stenoscelidea* within this tribe as the characters of the hind tibiæ are of greater importance than the form of the antennæ.

1. First joint of the antennæ much longer than the second

Uranocoris Walk.

First segment of the antennæ not longer than the second, often much shorter 2

2. Segments of antennæ prominently dilated 8

Segments of antennæ not dilated 3

3. Basal joint of antennæ short, shorter than length of head

Narnia Stal

Basal joint of antennæ long, as long or longer than length of head 4

4. Basal joint of antennæ equal to length of head, or slightly longer *Leptoglossus* Guér.

Basal joint of antennæ very much longer than length of head, 5

5. First and fourth segments of antennæ incrassated
Microphyilia Stal
 First and fourth segments of antennæ not incrassated. 6
6. Width of dilation of posterior tibiæ less than width across
 elytra. *Stenoscelidea* Hope.
 Width of dilation of posterior tibiæ greater than width across
 elytra. 7
7. Length of basal joint of antennæ less than twice the length of
 head. *Diactor* Perty.
 Length of basal joint of antennæ at least twice the length of
 head. *Anisoscelis* Latr.
8. Second segment of antennæ dilated, third also dilated. 9
 Second segment of antennæ simple, third dilated, *Baldus* Stal
9. Second segment of antennæ dilated on both sides
Chondrocera Lap.
 Second segment of antennæ slightly dilated above, not below, 10
10. Posterior lateral angles of thorax produced, or sharply angled
Holymeria Stal
 Posterior lateral angles of thorax not at all produced.
Tarpeius Stal

A PHYLOGENETIC STUDY OF THE TERGA AND WING
 BASES IN EMBIID, PLECOPTERA, DERMAPTERA,
 AND COLEOPTERA.¹

BY G. C. CRAMPTON, PH.D.,

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In a previous paper, the Plecoptera, Embiids, Hemimerids, and Dermaptera, were grouped in a superorder called the *Panplecoptera*, and a further study would indicate that the Coleoptera might be included in this group also. There is some doubt as to the Strepsiptera, but certain features point to a rather close relationship between them and the Coleoptera (as is generally thought to be the case, although the investigations of Pierce, 1909, have thrown some doubt upon the current idea of their affinities) and it is quite possible that the Strepsiptera should likewise be included in the superorder mentioned above.

¹ Contribution from the Entomological Laboratory of the Massachusetts Agricultural College, Amherst, Mass.

The Plecoptera, with the Embiids, are very like the ancestors of the insects comprising this superorder, (the Panplecoptera) while the Dermaptera form an offshoot which approaches the Isoptera in many respects—but the strongest affinities of the Isoptera seem to be on the side of the forms comprising the superorder *Pandictyoptera* (composed of the Isoptera Zoraptera, Blattids and Mantids). The Coleoptera have branched off very near the Dermaptera, and have retained certain ancestral features occurring in the Embiids and Plecoptera, but their line of development has apparently paralleled that of the Dermaptera quite closely. Some representatives of the Coleoptera exhibit certain features suggestive of those found in the Blattids; and other Coleoptera have retained certain structures (particularly in the larval stages) suggestive of Neuropteran affinities. However, since both the *Panplecoptera* and the *Pandictyoptera* are descended from common ancestors (which were not unlike the fossil Palaeodictyoptera) it is not surprising that certain features inherited from their common ancestors, should be carried over into both groups; and similarly, since both the Panplecoptera and the insects grouped about the Neuroptera were descended from similar ancestors (the ancestors of the Neuroptera were probably very similar to the Plecoptera) it is not surprising that similar characters should reappear in both the Neuroptera and Coleoptera. At any rate, the closest affinities of the Coleoptera seem to be with the Dermaptera, rather than with the Neuroptera (or with the Blattids) so far as the adult characters are concerned.

The Embiids are extremely closely related to the Plecoptera, as is shown by the character of their thoracic sclerites, legs, etc.; and the fact that the cerci of the Embiids are reduced, does not militate against the argument for the close relationship between the two orders, since certain Plecoptera also have the cerci reduced to two segments.

In both Embiids and Plecoptera, the body is more elongate, and the tergal region of the wing-bearing thoracic segments shows a marked tendency toward becoming longer than broad, in contradistinction to the condition found in the Coleoptera and Dermaptera, in which the tergal region exhibits a tendency to become broader than long, as may be seen by comparing Figs. 1 and 3 with Figs. 2 and 4. In the Embiids and Plecoptera, there is a prescutal

region "psc" demarked in both segments (Figs. 1 and 3), and situated well in advance of the wing bases, while the prescutal region is not so clearly demarked in the Coleoptera and Dermaptera (Figs. 2 and 4), and, when present in the latter insects, it is situated on a line with, or back of, the wing bases (or rather the anterior margin of the wing bases).

In the Plecoptera and Embiids, there is a well developed mesothoracic postscutellum ("psl₂"), while the mesothoracic postscutellum is not developed in the Coleoptera and Dermaptera, nor does the metathoracic postscutellum ("psl₃") dip downward at such a marked angle in the Coleoptera and Dermaptera (Figs. 2 and 4) as in the Embiids and Plecoptera (Figs. 1 and 3). The tegula ("tg") is well developed in both segments in the Embiids and Plecoptera (Figs. 1 and 3) while it seems to be lacking in the Coleoptera and in the metathorax of the Dermaptera, although the mesothoracic sclerite labeled "tg" in Fig. 4 is interpreted as the tegula in the Dermaptera, by Pantel, 1917, in his excellent monograph of the thoracic region of these insects.

In the Coleoptera (Fig. 2) a myodiscus, or muscle disk "d," to which are attached certain muscles connected with flight, occurs in the metathorax, and might be mistaken for the tegula. It is homologous with a smaller disk labeled "d" in the metathorax of the Dermaptera (Fig. 4, "d") which corresponds to the small disk "d" near the tegula "tg" of the mesothorax of the same insect (Fig. 4); and a similar small disk "d" occurs near the tegula in both mesothorax and metathorax of Plecoptera (Fig. 1). Snodgrass, 1908, in his earlier work, which was incorporated in his more extensive studies of the thoracic sclerites and wing bases of insects (Snodgrass, 1909) refers to the sclerite in question as the "muscle disc" in Coleoptera, but does not seem to have found it in other insects. Pantel, 1917, interprets the sclerite "d" in the metathorax of the Dermaptera (Fig. 4) as an intersegmental plate.

The terms axillaries, alar ossicles, and pteralia, have been applied to the little plates by means of which the wings articulate with the tergal region, and in a paper dealing with the nature and origin of the wings of insects (Crampton, 1916) it was pointed out that the alar ossicle "np" (termed the notopterale) is probably a detached portion of the notum or tergal region of the segment. A further examination of these alar ossicles would tend to confirm this sup-

position, since in the Embiids (Fig. 3), the alar ossicle "np" evidently is a portion of the notum which is not yet completely detached, while in the Plecoptera (Fig. 1, "np") it likewise extends for some distance closely applied to the lateral margin of the notum. The only winged Embiid which I have for examination is the male of *Embia major* shown in Fig. 3, but it is very probable that other Embiids will exhibit a type of alar ossicle similar to the elongate "notopterale" "np" of the Plecoptera (Fig. 1), and even in the Embiid shown in Fig. 3, the alar ossicle "np" is much longer than the homologous sclerites "np" of Figs. 2 and 4.

In the metathorax of both Dermaptera and Coleoptera (Figs. 2 and 4) the sclerite "np" is very similar in outline, and in position, being situated much further forward than in the Embiids and Plecoptera (Figs. 1 and 3), and it is not so elongate as in the Embiids and Plecoptera, as was mentioned above. In the mesothorax of the Dermaptera (Fig. 4), this plate "np₂" has become broken up into two parts, the anterior one of which is bent abruptly downward. This has resulted in the incorrect homologizing of the parts of this plate in the mesothorax of the Dermaptera, by some investigators, but the two parts of the mesothoracic plate "np₂" of Fig. 4 are clearly homologous with the single metathoracic plate "np₃" of the same insect.

Snodgrass, 1908-1909, refers to the mesothoracic plate "tg" (Fig. 4) of the Dermaptera, as "a small rod in wing base," apparently not realizing its true nature; but Pantel, 1917, correctly refers to it as the tegula. While the tegula "tg" is well developed in both meso- and metathorax in the Embiids and Plecoptera (Figs. 1 and 3), I do not think that it is developed in the metathorax of the Coleoptera and Dermaptera, unless the region designated as "t" in the metathorax of the Dermapteron shown in Fig. 4 represents the tegula. Pantel, 1917, refers to the region "ptg" in the metathorax of the Dermapteron shown in Fig. 4, as the metathoracic tegula, but this region seems to correspond to the so called parategula of Hymenoptera and Diptera (shown in Fig. 4 "ptg" of the wing base of a Dipteron, by Crampton, 1914_b).

Pantel, 1917, considers the metathoracic sclerite "su₃" of the Dermaptera (Fig. 4) as one of the pteralia, or articulatory ossicles at the base of the wing. As far as I can judge, however, the region "su" of Figs. 1, 2, 3, and 4, is merely an antero-lateral marginal

region of the tergum called the suralare (Crampton, 1914-1916) and serves as one of the pivots for the wing in the movements of flight, although it may become detached from the remainder of the tergum in a few rare instances, as Pantel considers to be the case in the Dermaptera. The posterior wing process "a" of the mesothorax is very similar in both Coleoptera and Dermaptera (Figs. 2 and 4), being rather long and slender in these insects, while it is shorter and more blunt when it occurs in other members of the group (Fig. 1, "a"). The basanal pterale "sa" is proportionately much larger in the metathorax of the Coleoptera and Dermaptera (Figs. 2 and 4) than in the Plecoptera and Embiids (Figs. 1 and 3).

In both the Coleoptera and Dermaptera (Figs. 2 and 4) there is a pronounced tendency for the tergal region of the wing bearing segments to become broader than long, and, with the Strepsiptera, and certain Orthoptera, these insects comprise the few forms in which the metathorax surpasses the mesothorax in size. Unlike the Plecoptera and Embiids, there is a well marked tendency in the Coleoptera and Dermaptera (Figs. 2 and 4) for the mesonotum to take on a triangular outline, and for the scutellar region of the mesonotum to become pointed posteriorly and to overlap the anterior portion of the metanotum behind it. Correlated with this tendency for the scutellum of the mesonotum to overlap the metanotum in the Coleoptera and Dermaptera, there is a well marked tendency toward the reduction of the mesothoracic postscutellum, which is well developed in the Embiids and Plecoptera.

In the metathorax of Coleoptera and Dermaptera (Figs. 2 and 4) two alar ridges or "alacristae" labeled "ac" serve to hold the elytra in place when at rest, and in many Dermaptera, they are provided with bristles which doubtless aid in holding the elytra in position. In both Coleoptera and Dermaptera, the metathoracic scutum is traversed by a "transscutal suture" ("tr" of Figs. 2 and 4) which is apparently absent in most of the other members of this superorder; and it is at once apparent from the study of the tergal region and the wing bases, that the Coleoptera are very similar to the Dermaptera in regard to these features, while the Embiids are very similar to the Plecoptera in the character of their tergal regions and wing bases.

The presence of the posttergal fold "pt" of Fig. 4 is a "Pandictyopterus" character (well developed in Isoptera, Mantids, etc.)

which has been retained in the Dermaptera, but has become lost, or was never developed, in the Coleoptera. A suggestion of this fold is also retained in the Plecoptera, as is shown in the posterior tergal fold designated as "pt" in the metathoracic region of the Plecopteron depicted in Fig. 1. There is a tendency for this region to become reduced, or to unite with the surface which it overlaps, so that the narrow continuation of the surface of this fold toward the point designated as "x" in the metathorax of Fig. 4, may possibly be homologous with the similar narrow continuation of the region beside the postscutellum, toward the point labeled "x" in Fig. 2 (at the base of the sclerite "sa").

In the foregoing descriptions, I have laid especial emphasis upon the resemblance between the Coleoptera and Dermaptera, as illustrated by the preponderance in size of the metathorax over the mesothorax; the relative width, and the outlines of the nota; the triangular shape of the mesonotum, and its overlapping the metanotum, with the consequent reduction of the mesothoracic postscutellum; the development of ridges in the metanotum for holding the elytra in place; the formation of a transscutal suture; the retention of the myodisc rather than of the tegula in the metanotal region; the outline and extent of the pteralia, etc. Similarly, the marked resemblance between the Embiids and Plecoptera is shown in the relative size of the nota, the width and the outlines of the nota; the location of the prescutum in front of the anterior margin of the wing-base; the development of the mesothoracic postscutellum; the development of the tegulae in both segments; the elongate notoptera, etc. On the other hand, in emphasizing these similarities between the Coleoptera and Dermaptera, or between the Embiids and Plecoptera, one should not lose sight of the fact that the Coleoptera and Dermaptera are both related to the Embiids and Plecoptera, although the Dermaptera, being the more primitive of the two, are nearer to the Embiids and Plecoptera than the Coleoptera are.

The cerci of certain larval Coleoptera, such as *Galerita janus*, and of certain Dermaptera such as *Diplatys severa* (in which segmented cerci precede the forceps of the adult forms) are very similar, even when the individual segments are compared together, and the cerci of both groups resemble those of the Plecoptera extremely closely, so that the evidence of the cerci would point to

a "Plecopteroid" ancestry for the Coleoptera and Dermaptera. The segments of the leg are very similar in Embiids, Plecoptera and Dermaptera, and the relationship of the Dermaptera to the Plecoptera is likewise shown by a comparison of the thoracic sclerites (or of the head region) of a nymph of the Plecopteron *Perla* with those of the Dermapteron *Arixenia*, the resemblance being very striking, as has been shown in a paper dealing with the thoracic sclerites of immature Pterygotan insects, which will soon be published. The tendency toward the shortening and thickening of the fore wings is quite marked in certain Plecoptera, and the pleural thoracic sclerites of the Embiids are in many respects very like those of the Dermaptera. In this connection, I would call attention to the fact that in the Embiids (Fig. 3) the nature of the postscutellar region of the metathorax and the first abdominal segment, with the bulging lateral regions, is very suggestive of the condition found in the Strepsiptera; but, since Dr. Pierce is making a comparison of the thoracic region of the Strepsiptera with other insects, which he finds more similar to the Strepsiptera than the Embiids are, the affinities of the Strepsiptera can be more accurately determined when the results of his extended studies are published.

Although the study of the terga and wing bases points to a close relationship between the Dermaptera and Coleoptera, and between the Embiids and Plecoptera, the evidence afforded by these structures alone is insufficient to establish the affinities of the insects in question. On this account, a comparative study of the structures least subject to modification, and those situated in widely separated parts of the body, has been undertaken in order to demonstrate the relationships here proposed. Such an extensive treatment of the subject, however, requires more space and plates than can be afforded a single article; so that the summing up of the arguments for the relationships here proposed, can be more convincingly set forth after the evidence from the more extensive study of the parts has been presented in the proposed series of articles dealing with this subject.

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1916. Crampton—Phylogenetic Origin of the Wings, etc. *Ibid.*, 24, p. 1—(Tergum and wing base of Plecopteron figured).
1917. Pantel—A proposito de un Anisolabis alado. *Mem. Real Acad. Ciencias y Artes*, 14, p. 3—(Numerous figures of terga and wing bases of Dermaptera).
1908. Snodgrass—A Comparative Study of the Thorax in Orthoptera, Euplexoptera, and Coleoptera. *Proc. Ent. Soc. Wash.*, 9, p. 95—(Terga and wing bases of Dermaptera and Coleoptera figured).
1909. Snodgrass—The Thorax of Insects and the Articulation of the Wings. *Proc. U. S. Nat. Museum*, 36, p. 511—(Terga and wing bases of Plecoptera, Dermaptera, and Coleoptera figured).

ABBREVIATIONS.

(The subscripts 2 and 3 denote mesothoracic and metathoracic structures respectively.)

- a . . Adanal process (adanale) sometimes a detached plate, but usually serving as a pivot for wing in movements of flight.
- abd. First abdominal tergum.
- ac . . Alacrista, or alar ridges for holding elytra in place when at rest.
- d . . Myodiscus, or muscle disc.
- m . . An alar ossicle, the medipterale.
- np . . An alar ossicle, the notopterale.
- p . . Chitinous area possibly homologous with the parategula.
- pa . . Prealare, or prealar sclerite.
- psc. Prescutum.
- psl. Postscutellum.
- pt . . Postplica, or posterior fold of tergal region.
- ptg. Parategula?
- s . . Spiracle.
- sa . . An alar ossicle, the basanale.
- ss . . Scutal suture.
- su . . Suralar process (suralare) serving as a pivot for movements of flight.
- t . . Region homologous with tegula?
- tg . . Tegula.
- tr . . Transcutal suture.

EXPLANATION OF PLATE I.

In all figures only a portion of the terga (which are symmetrical) has been shown, since the missing portions are exactly like those figured.

Fig. 1. Terga and wing bases of a Plecopteron.

Fig. 2. Terga and wing bases of the Coleopteron *Photuris*.

Fig. 3. Terga and wing bases of *Embia major*.

Fig. 4. Terga and wing bases of the Dermapteron *Echinosoma*.

ON THE OCCURRENCE OF A MERMIS EPIDEMIC
AMONGST GRASSHOPPERS.¹

BY R. W. GLASER and A. M. WILCOX.

While engaged in some investigations on grasshoppers, near Dummerston Station, southern Vermont, this past summer (1917), our attention was attracted to a high mortality amongst these insects (*Melanoplus atlantis* and *M. bivittatus*). The two species, especially *M. atlantis*, are extremely bad pests in this region of the country, attacking corn, wheat, oats and clover to such an extent that during certain summers the farmers become nearly frantic. Therefore, the high mortality amongst the grasshoppers, which appeared during the latter part of August and the early part of September, was exceedingly gratifying.

We soon discovered that this mortality was due to a species of Nematode belonging, as we supposed at the time, probably to the family Mermithidæ. Subsequently (Sept. 20, 25 and Oct. 6), we sent large shipments of these worms to Dr. N. A. Cobb, of Washington, D. C., for identification. Dr. Cobb was able to give us only a provisional identification on account of the utter absence of males in all of our shipments. We made collections of parasitized grasshoppers from a large variety of fields and as stated, sent a large number of specimens, but curiously enough no males were found. Dr. Cobb in a letter said: "Nothing I have learned would preclude your specimens from belonging to the same species as that referred to by Leidy under the name of *Mermis ferruginea*, which

¹ Contribution from the Entomological Laboratory of the Bussey Institution in coöperation with the U. S. Bureau of Entomology. Bussey Institution, No. 146.

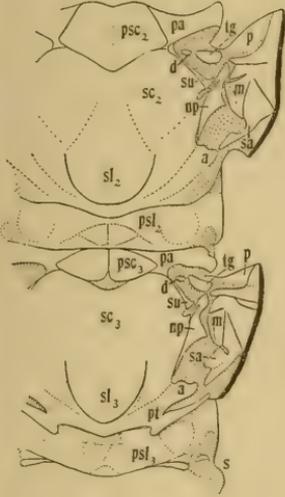


Fig. 1

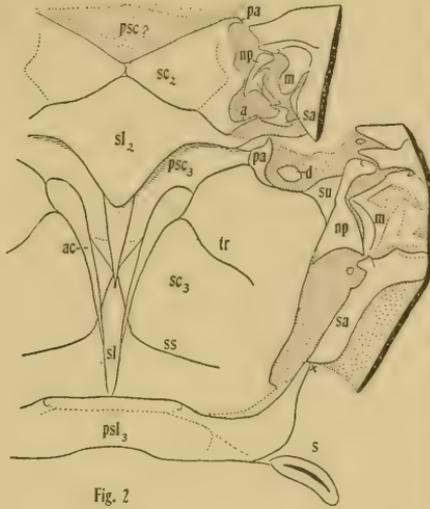


Fig. 2

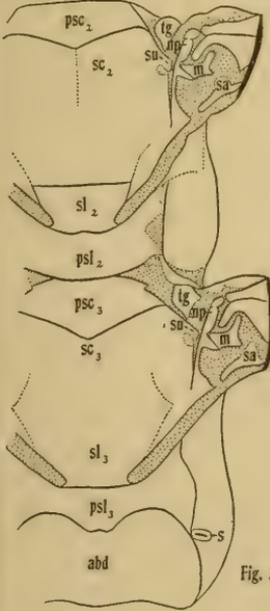


Fig. 3

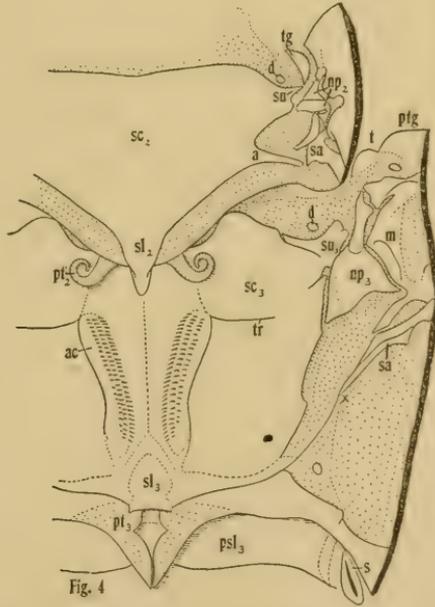


Fig. 4

he says was common in *Locusta carolina* near Philadelphia; but there can be no certainty about the matter until males of the present species are obtained and a comparison made with Leidy's material, which may or may not be in existence." Dr. Cobb further stated that after the nematodes leave the grasshoppers, they make their way into the soil and that their further history is obscure.

In Vermont the nematodes parasitized both *M. atlans* and *M. bivittatus*. The worms seem to leave the bodies of the grasshoppers when these insects are maturing. We had not the opportunity to observe grasshoppers in the early stages of parasitism, but in August and September dissection of a large number of the insects showed that the worms were located within the body cavity. Later in the season, when the worms are about to emerge, the grasshoppers fall over on one side, kick for a time and then die. In the meantime, the worms gradually bore their way through the body wall and reach the exterior after which they make their way slowly into the earth. Usually only one worm parasitizes a grasshopper, but by dissection we have often found two or three and in one case we found forty. Needless to say, that when an insect contains so many worms the abdomen is considerably swollen.

The length of these female worms varied from two to eight inches. It is extraordinary that with hundreds of hoppers dying everywhere, we were unable to find any males.

A great many nematodes, at one stage of their life cycle, seek water on leaving their hosts and there mature, or wait until another host presents himself. We placed about two dozen of our worms in a bowl of water in which they seemed to flourish for about two weeks. However, the localities where the hoppers, and consequently the worms abounded were free from streams, ponds or marshes of any kind. The Connecticut River flows through a valley at a distance of about one-half mile so it seemed unlikely that the worms would travel so far. In all probability, we thought, the worms make their way into the soil on leaving the insects and this we found true. We placed recently dead parasitized hoppers in boxes containing earth. In about three days the boxes were examined and the worms were found coiled up at a depth of about one foot. Often a number would be coiled up together in one

spot. An examination of the soil in the fields revealed quantities of the worms below the surface at a distance of six inches to one foot. November the 7th and 8th, long after the grasshopper season, the ground now cold was again broken and the nematodes were found coiled up at about the same distance below the surface. Undoubtedly they hibernate in these positions.

During the highest mortality we made a series of dissections in order to determine the per cent. of parasitism. On a place called the Halladay Farm, we obtained the following astonishing high figures by the dissection of *M. bivittatus*.

Sept. 8.	100 ♀ ♀	dissected and worms found in	59%
" 10.	80 ♀ ♀	" " " "	76%
" 12.	50 ♀ ♀	" " " "	62%
" 8.	40 ♂ ♂	" " " "	12%
" 10.	60 ♂ ♂	" " " "	21%
" 12.	100 ♂ ♂	" " " "	12%

On a place called the Tarbox Farm, we dissected about equal numbers of *M. bivittatus* and *M. atlantis* and obtained the following:

Sept. 8.	100 ♀ ♀	dissected and worms found in	22%
" 10.	75 ♀ ♀	" " " "	25%
" 12.	60 ♀ ♀	" " " "	25%
" 8.	90 ♂ ♂	" " " "	3%
" 10.	80 ♂ ♂	" " " "	5%
" 12.	100 ♂ ♂	" " " "	2%

In both series of dissections it will be noticed that the percentage of parasitism in females is much higher than in males. Since the life-history of the worm is still so obscure we are at present unable to offer any explanation for this fact.

How the grasshoppers become infected is unknown. Since the nematodes are so large when they leave the grasshoppers in order to burrow into the soil, we are under the impression that grasshoppers are the secondary hosts. It is difficult to imagine what animal might constitute the primary host. Perhaps some other insect may furnish the clue to this interesting question.

Next summer we hope to extend our observations and attempt to gain a more complete insight into the life-history of this *Mermis* parasite. Some parasites fluctuate so numerically from one season

to another, that an entirely different condition may, of course, present itself in 1918. We mean that the worms may not be so plentiful for some reason and if this should prove true, it will be difficult to obtain very much information.

From our observations this summer (1917) we firmly believe that the nematodes accomplished an immense reduction in the number of grasshoppers near Dummerston Station, Vermont. This worm, if its life-history is investigated, might offer possibilities for introduction into regions where it does not occur and where grasshoppers are a pest. For this reason, and because we were unable to find any records of such a high degree of parasitism, we thought it best to present these preliminary observations.

THE PULSATILE VESSELS IN THE LEGS OF APHIDIDÆ.

BY CHAS. H. RICHARDSON,

College of Physicians and Surgeons, Columbia University, New York City.

When one of the light-colored aphids, like *Myzus persicæ* Sulz., is mounted alive on a depression slide, a rapid beating motion can be detected with the low power of the microscope in the tibia of each leg just below its juncture with the femur. These centers of activity mark the position of the pulsatile vessels.

The structure of these minute and delicate organs in aphids is difficult to determine, but serial sections through the tibia show that they are undoubtedly tubular. In the large aquatic Hemiptera, where they were first studied, the structure is more easily seen. Berlese¹ describes them as tubular organs crossed obliquely with numerous muscle bands and continuous with a non-pulsating part on either side.

The function of these organs is clearly one of blood propulsion. Locy,² who studied them in the aquatic Hemiptera, was able to discern the direction of the blood currents in the immediate vicinity of the pulsatile vessels, one current moving inward, the other outward. In *Myzus persicæ*, upon which most of my observations

¹ Gli Insetti, Milano, 1909, p. 764, fig. 953.

² American Naturalist, Vol. 18, pp. 13-19, 1884 (1 pl.).

were made, the pulsations were rapid and irregular and for that reason difficult to count. A few attempts to determine the number per minute gave the following results: 150, 124, 176, 51. These must be taken as estimates only. Sometimes the pulsations would cease entirely in one leg for a number of seconds while continuing at the usual rate in the others. The periods of inactivity did not seem to be due to external stimuli. They occurred when the aphids were immersed in water or when placed on a dry depression slide. The movement of the dorsal heart was slower and of an entirely independent rhythm than that of the vessels.

Pulsations were observed in the very youngest aphids found. But no action was detected in large embryos, even those with the leg muscles and external spines well developed. Apparently the vessels are not functional till birth.

Loey has described the remarkable tenacity of these organs in the legs of *Ranatra*. In one case the vessel pulsed in an amputated leg for a period of 26 hours and 20 minutes. Activity continued even when sliced portions of the legs were used and when the vessel itself was cut in two, the posterior part still continued to pulsate. In contradistinction to this, the pulsatile vessels in the legs of *Myzus persicae* ceased beating (except for a few sporadic twitchings) immediately upon the removal of the legs. They would not resume their activity when the legs were quickly placed in water or physiological salt solution. If the head were cut off or burned off with a hot needle, the pulsations stopped at once. Aphids which were immersed in an aqueous solution of nicotine sulphate (1 part of 40 per cent. nicotine sulphate by volume to 500 parts of water), soon died and an immediate examination showed that the vessels in each leg had ceased to function. An injury from which the aphid finally partly recovered, such as a slight cut in the head, at first inhibited the action of the vessels, but with the recovery of the aphid, the vessels again resumed their normal rate of pulsation.

From the above results, it is evident that there is a marked difference in the reactions of the pulsatile vessels in *Ranatra* and *Myzus persicae* under certain abnormal conditions. Accepting *Ranatra* as the more generalized type, we notice a radical change in the resistance of the pulsatile vessels to various kinds of injury as we pass directly from this to the more highly specialized aphid

type. An analogous case is found in the vertebrates in which the excised heart of such a comparatively generalized type as the frog is much more resistant than the heart of a specialized mammalian type like the dog, the cat, or man.

There is every reason to think that pulsatile vessels will be found in most, if not all, families and genera of the Hemiptera and Homoptera. Their discovery in the Aphididæ simply adds to the already convincing evidence of the close relationship of these two groups.

ASCOGASTER CARPOCAPSÆ, A PARASITE OF THE ORIENTAL MOTH.

BY A. M. WILCOX,

Gipsy-moth Assistant, U. S. Bureau of Entomology.

The Oriental moth, *Cnidocampa flavescens* Walk., a native of Japan was first discovered in this country in 1906. Although at present the infestation is confined to a small area, there is a possibility of the moth becoming a widespread pest.

Several attempts have been made to rear parasites from the larvæ and cocoons of the moth, but as far as the writer knows, none of these previous attempts have been successful. During the spring of 1917 several of the cocoons were collected in Dorchester, Mass., and placed in rearing boxes. During the month of June the adults began to appear and a single Braconid parasite emerged at the same time. The specimen was determined by Prof. C. T. Brues of the Bussey Institution, Harvard University, as *Ascogaster carpocapsæ* Viereck. The species was first described as *Chelonus carpocapsæ* in 1909 by Viereck.¹ The Codling moth, *Carpocapsæ pomonella* was named as the host insect.

The species may be recognized by the absence of segmentation on the abdomen and by the presence of four transverse nipple-like prolongations on the outer and upper edge of the posterior face of the metathorax. It can readily be separated from *Chelonus fissus* Prov., a common, similar species, by the absence of pubescence on the eyes, and the different wing venation, the first submarginal and first discoidal cells being separated in *A. carpocapsæ*, while in *C. fissus* they are confluent.

¹ Proc. Ent. Soc. Washington, Vol. 11, p. 43.

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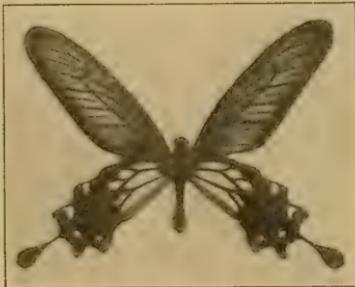
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KEY AND DESCRIPTIONS FOR THE SEPARATION AND DETERMINATION OF THE FIRST INSTAR STEM MOTHERS OF THE THREE SPECIES OF APHIDS MOST COMMONLY ATTACKING THE CULTIVATED APPLE.

By M. T. SMULYAN,

U. S. Bureau of Entomology, Melrose Highlands, Mass.

The following key and detailed descriptions were prepared in the spring of 1916, in Blacksburg, Va., while the writer was connected with the Virginia State Crop Pest Commission, and were to form part of a more extended paper, but as the publication of the latter has been delayed, these are submitted separately in the hope that they will prove of aid to those not yet familiar with the young stem mothers of the above three species of aphids.

KEY.¹

Cornicles long (about $\frac{1}{6}$ to $\frac{1}{10}$ of length of insect). Fig. 1, B.

(Base of distal segment of antennæ distinctly shorter than the flagellum or unguis or distinctly less than one-half the total length of the segment.) Fig. 1, A.....1. *Aphis malifolia* Fitch (*Aphis sorbi* Kalt. of recent American authors).

Cornicles short or very short (longest about of the length of an abdominal segment). Figs. 2 and 3, B.

Base of distal segment of antennæ as long or nearly as long as the unguis or equal or nearly equal to one-half the total length of the segment; cornicles about as long as an abdominal segment. Fig. 2, A and B.....2. *Aphis pomi* DeG.

Base of distal segment of antennæ distinctly shorter than the unguis or less than one-half the total length of the segment; cornicles tuberculiform. Fig. 3, A and B....3. *Aphis prunifolia* Fitch (*Aphis avenæ* Fab. of recent American authors).

¹The characters utilized here, as well as most of those embodied in the descriptions, can be made out by means of a hand lens or binocular microscope. The figures were drawn from balsam mounts.

DESCRIPTIONS.

1. *A. malifoliae* Fitch (Rosy Apple Aphis).

Light to dark green, anterior portion of thorax (first two segments as a rule) usually lighter (light green may have a yellowish tint); anterior and dorsal aspects of head, antennæ, base and nearly $\frac{1}{2}$ distal portion of rostrum, legs, apices of cornicles, and as a rule two transverse bands or lines at anal end of dorsum, dusky to black; the remainder of cornicles often dusky or brownish; eyes dull black (in balsam-mounted specimens deep red); as a rule a pale median longitudinal line on dorsum of head; often a small dusky median spot on the first thoracic segment (in good light seen to be interrupted medianly and longitudinally) and one on each side of the thoracic segments; caudal end of abdomen ventrally dusky sometimes; dorsum of head and thorax and the whole of the ventral surface of the insect more or less pulverulent. Newly-hatched specimens are light green as a rule, with head, thorax, and posterior portion of abdomen at sides, occasionally, pale yellowish-green; appendages similar to head and thorax, although the antennæ and legs are more often almost colorless; eyes deep red.

Antennæ comparatively long and varying in extent from end of

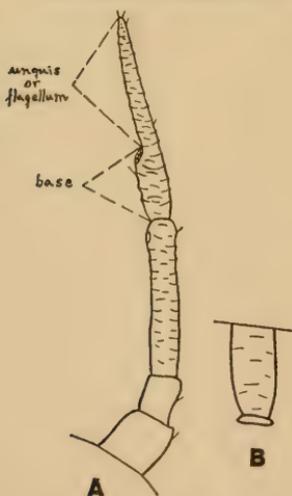


Fig. 1.—Antenna and cornicle of *Aphis malifoliae* Fitch, about $\times 150$.

thorax nearly to bases of cornicles, unguis about twice as long as base of distal segment, segments as follows: III .1155–.1386 mm., IV (base) .0539–.0616 mm., IV (unguis) .1001–.1309 mm., III with a distal sensorium and base of IV with a distal group composed of one large one and several smaller ones, III and IV imbricated but III not as strongly, III sometimes showing faint line of differentiation of future segments III and IV, the whole with a few short spinelike hairs; cornicles long .0770–.0847 mm., broad, cylindrical or subcylindrical (in some balsam-mounted specimens distinctly tapering), flanged at apices, often in part weakly imbricated.

cated, and varying in extent from beyond end of body to somewhat short of end of same; rostrum varying in extent from nearly to end of body to about metacoxa (relative length varying, like that of antennæ and cornicles, with the state of advancement of the insect—relatively shorter with feeding and consequent enlargement of body); legs armed with spinelike hairs, anterior tibiæ .1540–.1848 mm., intermediate tibiæ .1617–.1925 mm., metatibiæ .2002–.2464 mm.; anterior tangent of head usually faintly trilobed; eyes somewhat large; usually a pair of minute tubercles on each of last two segments (within transverse dusky lines or bands), and very often apparently a median double row of very minute tubercles or dots on remainder of dorsum, a pair on each segment; length of body .4620–.8316 mm., width at widest part .2464–.4312 mm.

2. *A. pomi* DeG. (Green Apple Aphis).

Dark green (well fed individuals may be lighter), anterior and dorsal aspects of head dusky to blackish with a pale or uncolored median longitudinal, often quite wide, band or stripe (when latter condition obtains the dark or dusky portion appears as two elongate spots); antennæ, base of rostrum, and legs dusky, tips of femora, distal portions of tibiæ, and tarsi quite often blackish; more or less of cornicles, and about $\frac{1}{3}$ distal portion of rostrum black or blackish; eyes black (in mounted specimens deep red); caudal end of abdomen ventrally sometimes faintly dusky; whole insect often slightly pruinose. Newly-hatched specimens are bright dark green, with head and more or less of anterior portion of thorax as a rule lighter and usually with a yellowish tint; antennæ, rostrum, and legs with a cast of the color of the body, tips of femora and of tarsi and distal portions of some of the antennal segments very often darker green; femora usually distinctly yellow-green.

Antennæ reaching from end of second segment to end of thorax, base and unguis of last segment equal or subequal (the inequality is slight when the specimen is not too highly

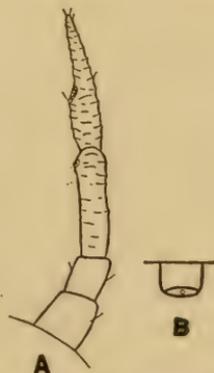


Fig. 2. — Antenna and cornicle of *Aphis pomi* DeG., about $\times 150$.

magnified), segments as follows: III .0924-.1001 mm., IV (base) .0462-.0539 mm., IV (unguis) .0539-.0616 mm., III with a distal sensorium and base of IV with a distal group composed of one large one and several smaller ones, III as a rule imbricated but not as strongly as IV, the whole with a few short spinelike hairs; cornicles short, .0231 mm., broad, cylindrical or very nearly so, and rounded at distal end; rostrum reaching to or extending somewhat beyond metacoxa (varying in extent like antennæ, with feeding, as in *malifolia*); legs armed with spinelike hairs, anterior tibiæ .1463-.1771 mm., intermediate tibiæ .1617-.2079, metatibiæ .1925-.2387 mm.; prothoracic and first and last pairs of abdominal lateral tubercles comparatively prominent and the last abdominal pair usually quite conspicuous—(all lose in conspicuousness as the insect body enlarges, but under higher magnification the last abdominal pair is quite easily made out in live specimens which have not fed too far, and is a very good distinguishing character); length of body .5236-.8162 mm., width at widest part .2772-.4004 mm.

3. *A. prunifoliæ* Fitch (Apple-Grain Aphis).

Dull light green or dull dark green, anterior and dorsal aspects of head dusky to blackish and very often with a pale or uncolored median longitudinal line; antennæ, base of rostrum, caudal end of abdomen ventrally, and legs dusky—distal portions of femora, tibiæ, and of tarsi may be still darker; cornicles and about $\frac{1}{3}$ distal portion of rostrum black or blackish; eyes black (in mounted specimens deep red). Newly-hatched specimens are light green, with head and thorax (at least first two segments) still lighter or pale yellow-green; appendages with a cast of the color of the body, although practically colorless in part sometimes; femora usually yellow-green.

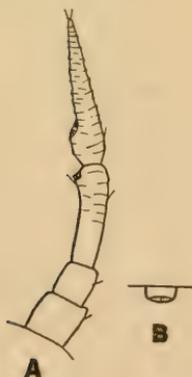


Fig. 3.—Antenna and cornicle of *Aphis prunifoliae* Fitch, about $\times 150$.

Antennæ stoutish, reaching to about end of thorax and “shortening up” somewhat with feeding, flagellum or unguis about twice as long as base, segments as follows: III .0924-.1001 mm., IV (base) .0385-.0462 mm., IV (unguis) .0847-.1001 mm., III with a distal sensorium and base of IV with a distal group composed

of one large one and several smaller ones, IV imbricated and III as a rule in part faintly, the whole with a few spinelike hairs; cornicles very short, tuberculiform; rostrum reaching from somewhat beyond metacoxa nearly to end of body (relative length, like that of antennæ, varying as in the other two species); legs stoutish and armed with spinelike hairs, anterior tibiæ .1540–.1925 mm., intermediate tibiæ .1694–.2079 mm., metatibiæ .2156–.2387 mm.; length of body .4620–.8470 mm., width across widest part .2618–.4004 mm.

A. prunifolia is the first of the three to begin hatching, and in Virginia it may begin as early as the middle of March. The other two follow in about ten days to two weeks.

MYRIAPODS FROM NASHVILLE, TENNESSEE.

BY RALPH V. CHAMBERLIN,

Museum of Comparative Zoölogy, Cambridge, Mass.

The myriapods listed below are represented in a collection made by Mr. Harold Cummins of Vanderbilt University in and near Nashville and by him kindly sent to me for study. The collection is interesting particularly because it includes numerous well preserved specimens of a new diplopod genus of the family Nannolenidæ. Three other forms represent new species, two of *Fontaria* and one of *Parajulus*. There is a total of twenty-five species.

CHILOPODA.

1. *Geophilus mordax* Meinert.

Two specimens taken in the Glendale Hills south of Nashville, one on Oct. 14, 1916, and one in March, 1917.

2. *Arenophilus bipuncticeps* (Wood).

One specimen labeled as found on "Nolensville Pike, Nashville, Feb. 25, 1917," and another labeled "Nashville, Nov., 1917."

3. *Gnathomerium umbraticum* (McNeill).

One specimen taken in the Glendale Hills in April, 1917.

4. *Theatops posticus* (Say).

Glendale Hills. One specimen taken May, 1917, and one March 25, 1917.

5. *Otocryptops sexspinosus* (Say).

Seven specimens of this abundant and widespread species. Four from Glendale Hills taken March 25, April 21 and in May, 1917; and three specimens taken beyond Glendale Oct. 14, 1916.

6. *Hemiscolopendra punctiventris* (Newport).

One specimen, Glendale Hills, April 21, 1917.

7. *Sozibius providens* (Bollman).

Glendale Hills, April 21, 1917. One specimen.

8. *Lithobius mordax* Koch.

Several specimens. One pair were taken "around pond between Gallatin and Nolensville Pike," March 14, 1917. A second pair at Belle Meade, Jan. 28, 1917.

9. *Lithobius transmarinus* Koch.

Several specimens of this form taken south of Nashville, Oct., 1916.

10. *Bothropolys multidentatus* (Newport).

Glendale Hills, April 21, 1917. One male.

11. *Scutigera forceps* (Rafinesque).

Nashville, May 6, 1917. One adult specimen taken "under a flat stone on a rather barren hillside."

DIPLOPODA.

12. *Platydesmus lecontei* (Wood).

Beyond Glendale, Oct. 14, 1916. Two specimens.

13. *Callipus lactarius* (Say).

Numerous specimens. Beyond Glendale, Oct. 14, 1916; south of Nashville, Nov., 1916; Nashville, March 25, 1917; and Glendale Hills, April, 1917.

14. *Cleidogona cæsioannulata* (Wood).

Beyond Glendale, Oct. 14, 1916. One specimen.

15. *Cambala annulata* (Say).

Nashville, March 25, 1917. One specimen.

Choctella gen. nov.

A Nannolenid genus which has the usual form and proportions of Spirobolus.

Mandibular combs 7.

Gnathochilarium as in Nannolene and Epinannolene.

Ocelli in several series, arranged in a triangular patch.

Repugnatorial pores beginning on the sixth somite, each pore in front of the transverse suture of the somite.

Antennæ short, composed of 7 articles of which the fifth and sixth are clavately enlarged.

Second and third articles longest, subequal; fourth, fifth and sixth but little shorter, subequal. Head below eyes deeply subvertically grooved, for the reception of the proximal portion of antennæ.

Dorsal plate of first somite large, extending forwards on a portion of head and largely concealing the antennæ.

First and second legs in male reduced in size but armed and otherwise similar to the succeeding pairs.

All somites excepting the first and last strongly longitudinally striate beneath and almost half way up to the repugnatorial pore, elsewhere smooth.

Posterior border of last segment above rounded, exceeded by the anal valves. Mesal edges of anal valves meeting in a distinct groove.

Gonopods well exposed. Gonopods two pairs, coleopods and phallopods respectively, the seminal duct traversing the latter.

Each coleopod simple, thin, plate-like, and undivided.

Phallopods also undivided.

Genotype: *Choctella cumminsi* sp. nov.

16. Choctella cumminsi sp. nov.

The general color below is black excepting the caudal, overlapping border of each somite. Dorsally the somites remain dark in a more or less narrow band adjacent to this pale posterior border elsewhere bearing greyish yellow or more typically in part reddish, the color rather irregular in arrangement. Ordinarily the light markings of the dorsum are less extensive anteriorly than elsewhere, the caudal segments also in some being similarly darker than the middle ones. Head in general greyish black. Labrum

and adjacent region of head and narrow borders of first somite also reddish. Antennæ blackish. Legs dusky reddish brown. Anal valves reddish brown along their contiguous mesal margins.

Body *Spirobolus*-like in general form and appearance. Of uniform diameter throughout excepting the first few and last few somites. Surface in general appearing smooth and shiny but each somite excepting the first and last marked below on each side with a series of strong longitudinal striæ which do not extend up on the sides, the striation extending farther dorsad caudad of the suture than in front of it.

First repugnatorial pore on the sixth somite. Pores large, each in front of and well removed from the transverse suture.

Head with a pronounced vertigial sulcus connected from its anterior end to each eye by means of a finer transverse sulcus. Below this the surface is roughened by singular sulci which are more prominent laterally, but the smooth antennæ short, clavate, with the first two articles normally lying in a deep groove in front of and below the eye; first four articles sparsely hairy, the remaining ones densely clothed; sensory cones pale, distinct.

Eyes black, triangular, transversally-elongate; ocelli in 5 or 6 series; 30 to 40 in number. Setigerous foveolæ 3 + 3.

Plate of first somite large, extending over head to the transverse suture between eye and normally covering greater part of antennæ. Anterior margin curving broadly moderately forward on the sides, the lower anterior corner evenly rounded, the caudal corner projecting somewhat caudad and more narrowly rounded. The lower anterior and the ventral border elevated and set off by a suture, which does not extend across mid-dorsal region. No other distinct sulci.

Last somite a complete annulus much larger above than below with the caudal dorsal margin evenly rounded and surpassed by the anal valves. Anal valves ventrally smooth.

Seventh somite in male moderately produced below. Genopods well exposed. Coleopods simple, thin plates, each of which is moderately narrowed distad and narrowly rounded at the apex; below apical portion the mesal border of each is bent subcaudad. Phallopods exceeded by the coleopods. Each with distal division narrowly subconical, distally curving mesad, the tip somewhat obliquely truncate.

Number of somites 44 to 48.

Average length near 50 mm. with diameter 4.8 mm.

Localities. Glendale Hills, south of Nashville. Nine specimens April 21, 1917 and three specimens March 25, 1917.

17. *Parajulus pennsylvanicus* (Wood).

Beyond Glendale, Oct. 14, 1916. One female apparently this species.

18. *Parajulus nigrans* sp. nov.

The color is very dark, blackish throughout without definite paler spots or annuli. Feet also dark.

Body rather slender, obviously narrowing caudad. In general smooth, not pilose, but a few stiff, somewhat curved setæ on last segment and anal valves. Somites strongly longitudinally striate beneath and across lower part of sides.

First segment long, with the lower margin straight; margined below and over lower part anteriorly but not at all striate.

The anal plate above is acute but is not at all produced; it is clearly exceeded by the anal valves and bears a series of setæ along its caudal margin. Anal valves mesally margined.

Head with a median vertigial sulcus ending at a deeply impressed arcuate transverse sulcus extending between the eyes. Nearly smooth. Eyes triangular, each composed of about 36 ocelli arranged in 8 transverse series.

Repugnatorial pore moderate, contiguous or nearly so with the suture which is straight or rarely very slightly curved opposite the pore.

In the male the mandibular stipes strongly produced at the antero-inferior angle, the apex of the process being on nearly the same level as the inferior margin of the labrum.

Each first gonopod of the male is placed antero-lateral of the corresponding second one. Its anterior division is a flat plate about half as high as the posterior division against which it lies; its distal end is rounded. The second or posterior gonopods rise clearly above the anterior plates. Each above its base is a thin, flat blade with edge subapical, which near its middle curves caudad and then somewhat dorsad. Not at all narrowing dorsad, its free distal end truncate; from the basal portion a slender acutely pointed blade curves mesad and crosses the one from the other side.

Number of somites 51.

Length near 30 mm. Width at anterior end 2 mm.

Locality. Near Nashville. "Under stones in juniper patch near Nolensville Pike." Feb. 19, 1917. One male.

19. *Spirobolus marginatus* (Say).

One specimen taken in the Glendale Hills, April 21, 1917.

20. *Polydesmus canadensis* Newport.

A number of specimens of both sexes. Belle Meade, Jan. 28, 1917. Nashville, Feb. 25, 1917, and April 26, 1917 "under stones in a damp spring house." Glendale Hills, April, 1917.

21. *Polydesmus moniliaris* Koch.

Three specimens from the Glendale Hills, April, 1917.

22. *Euryurus erythropygus* (Brandt).

Eight specimens, four from "beyond Glendale," Oct. 14, 1916, and four from Glendale Hills, April, 1917.

23. *Fontaria tennesseensis* Bollman.

Glendale Hills, April 21, 1917. Two adult and two immature specimens.

24. *Fontaria glendalea* sp. nov.

Dorsum and head shining brownish black with the lateral carinæ alone yellow in the preserved specimen. Antennæ dark reddish brown. Legs yellow.

Body distinctly narrowing forward in male over the first four somites. Lateral carinæ large, in middle region posterior margin straight, transverse or nearly so, the ectocaudal angles in posterior plates moderately extended caudad. Surface to naked eye appearing smooth, under lens seen to be finely corrugated.

Repugnatorial pore on dorsal side of carina from the ectal edge of which it is well removed.

Vertigial sulcus of head deep. Head smooth. Occipital foveolæ 2+2, the clypeal 1+1.

In the male the caxæ of legs without processes. The sternites also without processes excepting a pair of contiguous subconical ones on the fourth somite, these being flattened anteroposteriorly. Genital processes of second somite short, cylindrical, distally truncate.

Basal lobe of each gonopod strongly setose on mesal side. Exterior division with setæ on posterior edge over basal and middle region; the branchis constricted above here into a slender blade of uniform width until the next to the distal fifth of length over which it is expanded to nearly double the width and then again narrows to a tongue which at its distal end is attenuated into a slender, distally bristle-like tip. About the distal three-fifths, or less, of the exterior blade is strongly bent upon itself roughly into a U-shape, with the slender tip at right angles to the arm bearing it. The basal spine short, slight, curved, acute.

Length about 39 mm. Width 10 mm.

Locality. Glendale Hills, south of Nashville, April 21, 1917.

Two adult males, one adult female and four immature individuals. Closely related to *F. rileyi* Bollman, described from Macon, Georgia.

25. *Fontaria mimetica* sp. nov.

General color at present dusky brown with the carinæ and borders of somites yellow. Of reddish caste and probably red in life. The posterior band of color usually widest at middle. The first somite with anterior as well as posterior border of the lighter color. Head light at sides and below level of antennæ. Antennæ deep reddish brown or chestnut. Legs yellowish.

Body conspicuously narrowed cephalad over the first four somites. Carinæ very much as in glendalea but with the caudal angles in general more produced.

Repugnatorial pore dorsal in position, widely removed from lateral edge.

Vertical sulcus distinct. Occipital foveolæ 2+2; antennal and clypeal 1+1.

Sternite of third somite in male with two processes fused into a single conspicuous median body which is somewhat constricted at base. Fourth sternite with two separate subconical processes. Coxæ without spiral process aside from those giving exit to the genital ducts on the second pair.

Fifth sternite with two low, rounded eminences.

The general form of the gonopods as in glendalea, strongly coiled nearly into a complete circle open below, but the exterior division much broader, at first cylindrical, then flattened and near

end of middle third of length narrowing to a much narrower blade which distad expands a little, somewhat clavately, the end being rounded, with no acute or spine-like process. Basal spine short and stout, at tip subconically narrowed, the apex narrowly rounded.

Length near 42 mm. Width 10 mm.

Locality. Glendale Hills, south of Nashville. April 21, 1917.

One male.

Hillsboro Hills, Nashville, April 22, 1917. One female apparently of this species.

Also "Beyond Glendale," Oct. 14, 1916. One male and an immature specimen. The male is not in full color, the brighter carinal and marginal markings being scarcely evident. The general color is dusky over a dull yellow background. A dark median longitudinal dorsal line shows posteriorly. It appears to be a recently moulted individual.

NOTES ON DIPTERA.¹

BY J. M. ALDRICH.

(a) In studying the habits of the "salt-fly" of Great Salt Lake (*Ephydra gracilis* Pack.) in 1911, I noted that trains crossing the lake on the famous Southern Pacific cutoff west of Ogden raise a constant swarm of these flies for an hour, and many of the insects get into passenger trains in spite of efforts to keep them out by closing the windows. My report says (Jour. N. Y. Ent. Soc., xx, 84, 1912), "They become a nuisance . . . in the dining cars. I had no difficulty in finding some of the flies in the latter situation as far west as Reno, Nev., and I doubt not that they may be found after the cars reach Oakland."

I can now add that the species has established itself in San Francisco Bay. On July 10, 1917, in sweeping about several little saline pools close to the shore of the Bay next to Palo Alto, I captured 18 specimens, indicating that it is a common species 30 miles south of the Oakland mole. I had no opportunity to examine other portions of the Bay shore.

Prior to the running of trains across Great Salt Lake, which

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began in 1904, there was no such opportunity for the flies to be carried, as the trains did not run close enough to the water.

That the species is not indigenous to San Francisco Bay is fairly well demonstrated by the following facts: (1) It was not in the Stanford University collection, which is rich in local Diptera, the accumulations of many years, and is only about $2\frac{1}{2}$ miles from the place where I recently found the species; (2) It is not in the collection of the University of California, although a few years ago an advanced student, Burle R. Jones, made and published a special study of California Ephydridæ, for which he collected extensively about the Bay (Catalogue of the Ephydridæ, etc. Technical Bull., Cal. Agr. Exp. Station, 1908); (3) It is not in the collection of the California Academy of Sciences, nor was it in the old collection destroyed by fire in 1906, as I personally know from examination; (4) In 1905-6 I collected repeatedly along the Bay near Palo Alto, and visited the same place again once in 1911, without finding the species.

As a matter of fact, up to the present report there have been only about half a dozen specimens of the species ever found away from Great Salt Lake; these are from Yuma and Salton Sea in the National Museum, one from Laguna, Cal., taken by C. F. Baker, and one from "S. Cal." which Jones made the type of *Ephydra cinerea*. The last two, which I have studied, are larger than the average but not larger than the largest specimens from Great Salt Lake, and the same is true of the 18 specimens I secured near Palo Alto last summer. This perhaps indicates that the extreme density of the water in Great Salt Lake exercises a dwarfing influence upon the species.

(b) When Van der Wulp described *Charadrella macrosoma* new genus and species, from Northern Yucatan (Biologia Cent.-Amer., Dipt., ii, 341, 1896), he added the following note:

"As the fourth vein is not curved, but runs directly to the tip of the wing, this genus is included here among the Anthomyiinae; on account, however, of the presence of a perpendicular row of macrochaetæ on the hypopleuræ, before the halteres, it would not belong to the Anthomyiinae in the sense of Girschner's system of the Muscidae Calypterae."

An Anthomyiid with hypopleural bristles would be anomalous indeed, and I have long desired to see the species. The desire was

gratified last January, when I found it correctly identified in Professor Hine's collection from Guatemala and British Guiana. The specimens agree with Van der Wulp's description throughout, except for one thing:—there is not the slightest trace of the row of hypopleural bristles. The genus has so many strong characters that misidentification seems impossible; the only other explanation of the discrepancy is that Van der Wulp saw the bristles on some other fly and got it confused with this species, and this I think is what happened.

Since *Charadrella* has a number of unusual features, and does not fit well in any of the subfamilies recognized by Malloch in his recent tabulation (*Canad. Ent.*, Dec., 1917, 406), I add the following mostly chaetotactic characters taken from one of Professor Hine's males:

Head: front one-fourth the head-width at vertex, widening forward very gradually; frontals in a single row, about 10, the lowest just at the antennal insertion; ocellars broadly diverging, slightly proclinate; no cruciate bristles; verticals as usual but not strong; vibrissæ large, just at the lower edge of head, above them a patch of small black hairs extending more than halfway to root of antennæ and nearly halfway to the eye; infra-orbital cilia (setæ) pale.

Thorax: ps dc 3 (from the spacing 4 will probably also occur), ant dc 2, hum 4, posthum 1, prs 1, npl 2, intal 2, supal 3 (of which the prealar is less than half as long as the next), postal 2, ant acr 0, post acr 1 (prsc), stpl 3 (the anterior small, posterior 2 close together vertically), mesopleura with 3 at lower front corner and a row of 6 behind, sternopleura and mesopleura with upright rather long pale hairs which also cover the pteropleura, hypopleura bare; scutellum with two long pairs, marginal and apical, and several small submarginal, the disk very hairy; both spiracles very large; hind calypter much exceeding front one; scutellum bare below.

Abdomen: first and second segments without bristles above, third with 4 marginals, fourth with 6 marginals and a discal pair so far apart that they stand almost at the edge; sternites 2-5 with a few bristles; 2-4 separated from the tergites by a wide membrane; genitalia small.

Wing: third and fourth veins strongly divergent toward tip,

the third sinuous, ending a little before apex, fourth very slightly turned forward near tip, less than third; no setæ on any veins, no costal spine; sixth vein does not reach margin, seventh parallel with it.

Legs: tibiæ almost without bristles, hind basitarsus not with spine below.

(c) In the Carnegie Museum are three flies which were probably captured farther north than any others on record. They were taken by J. W. Goodsell, surgeon of the Peary Expedition, and are labeled, "82 degrees north latitude, on the beach at the northeastern extremity of L. Hazen, in the interior of Grant Land. June 7, 1908." This would be about 550 miles from the pole. One of the specimens is *Fucellia pictipennis* Beck., a species described from Greenland and taken since in the Arctic by the Canadian Arctic Expedition. The other two specimens belong to *Phormia terræ-novæ* Desv., described from Newfoundland and again from Greenland, a circumpolar species which is common in the mountains of the western states and occurs rarely in lower altitudes (Indiana, New Jersey):

(d) Two or three years ago Professor Johannsen inquired of me if I had any males of Lonchoptera. On going over my material, I was surprised to find but two males;—one from Colorado, taken by C. F. Baker, the other from the Parry Sound region of Ontario, taken by H. A. Parish. My attention being thus directed to the rarity of males, I followed up the matter during my sweeping work in the summer of 1916, noting in each sweeping the number and sex of the Lonchopteras. At the end of the season I had counted 2,652 specimens, all females, not a single male appearing. Most of these were taken in northern Indiana, but many were from other parts of the United States, and a few from Ontario.

In this connection should be mentioned Mr. Lundbeck's treatise on Lonchoptera in his beautiful series called *Diptera Danica*, v, 1-18, 1916. He recognizes in Denmark three species,—*tristis*, *lutea* and *furcata*. He says nothing about any rarity of males in the first two, but in *furcata* he says he has not seen the male, and only about six are known in collections, while the female is common. This is a parallel case, if in fact we do not have the same species, as I believe we do.

(e) The common leaf-miner *Agromyza pusilla* has many host-

plants; I have reared it from mines in leaves of the common milkweed, *Asclepias syriaca*, and have found apparently the same maggot in leaves of horsemint, *Monarda punctata*. These two plants seem rather unfavorable for the purpose, on account in the one case of the abundant milk, and in the other the fiery taste. Yet on closer investigation neither of these qualities hinders the miner. In the case of milkweed, the miner feeds in the palisade tissue and does not touch the laticiferous system lying lower down in the leaf. If it should by accident cut into these vessels, it would no doubt be drowned in the outflow of milk, but apparently this does not happen. It enters and departs by the upper surface.

In the case of *Monarda* the explanation is not so easy to get at. The hot taste comes from the essential oil, of course, and it seemed that this must occur in some tissues not attacked by the maggot; but I asked several botanists in vain as to the location of the oil deposits. At length Dr. W. N. Steil, of the botanical department of the University of Wisconsin, told me that the identical point had been investigated in that department; he looked it up and kindly wrote me that the oil was found to occur only in the trichomes in *Monarda*. These being entirely superficial organs, of course the maggot does not eat them.

No special instinct would seem to be necessary in either of these cases.

(f) In Melander and Spuler's paper on Sepsidae (Bull. 143, Wash. Agr. Exp. Station) they mention on page 44 my capture of *Themira putris* L. attending plant-lice on cottonwood, and the same record occurs in my Catalogue of Diptera, page 619. As a slight contribution to the history of the spread of the species I will add that this occurred four miles north of Brookings, S. D., on Aug. 9, 1891, ten years before the first record of the occurrence of the species in North America, which record was by G. Chagnon, in *The Entomological Student*, ii, 13, 1901; his locality was Montreal. My specimens attending plant-lice were on a tree a few feet from a privy, and this was probably the source of the flies. I still recall my exultation when I succeeded in tracing the species in Schiner's *Fauna Austriaca*, and found it new to North America.

(g) *Chrysomya demandata* Fabr. was first reported from North America by C. W. Johnson in *Ent. News*, xi, 609, 1900; localities were Philadelphia and Riverton, N. J. The year of capture is

given by Knab as 1897 in Science for January 14, 1916,—presumably he took it from specimens sent by Johnson to Coquillett for determination. The earliest date on specimens in the collections of the Illinois State Laboratory of Natural History is August, 1908, and Tucker reported it from Kansas in the same year (Kans. Acad. Sci., xxii, 278, 1908), but probably collected it earlier. In the Pacific Northwest, I collected a specimen at Pendleton, Ore., on May 19, 1907; Mr. Wm. M. Mann secured two at Wawawai, Wash., on Aug. 30, 1908; and it was common on carrot flowers at Moscow, Idaho, on Sept. 4, 1908. It was in Arizona in 1910 (C. N. Ainslie, Proc. Ent. Soc. Wash., xiii, 118). These items may be of service in tracing the spread of the species.

(h) I am indebted to W. H. Dall, of the National Museum, for further information about the *Psilopus* of Poli, 1795, which was long supposed to preoccupy the same name as applied to a genus in the Dolichopodidæ. Poli's large work, "Testacea utriusque Siciliae," is unique as a taxonomic effort, in that the writer used a complete double set of names,—a genus and species for each kind of shell, and an entirely different genus and species for the soft parts of the same mollusc. Thus the system is tetranomial rather than binomial, and Dr. Dall informs me that it is considered by taxonomists in Mollusca to be entirely outside of nomenclature; he added in reply to my question that he was not aware of any controversy whatever on the point. This is the same point of view expressed by Sherborn in *Index Animalium*, noted by me in *Canadian Entomologist*, 1910, 100. Since it seems that Poli's work is the same nomenclaturally as if it had never been written, there can be no objection to the use of *Psilopus* by Meigen in 1824.

In this connection it may be well to add that the distinctions upon which I based *Gnamptopsilopus* 1893, and recognized *Agonosoma* as distinct from *Psilopodinus* in my Catalogue of 1905, break down entirely in the oriental region; so I would not include all in *Psilopus*.

BOOK REVIEWS.

FIELD BOOK OF INSECTS. Lutz, F. E. 509 pp., pocket octavo, 101 plates of numerous figures. G. P. Putnam's Sons, New York, 1918. \$2.50.

This book is an innovation among insect books in several ways. It is printed on thin paper with narrow margins and on this account contains more material than would appear from its exterior; it includes keys to the families of some orders, to the genera of some families and to the species of a few groups of conspicuous insects like the longicorn beetles, household flies, bumble-bees, etc.; and lastly it is written by one who has had unusual opportunities to find out what the "layman" really wants to know about insects. From the latter it must not be inferred that the entomologist will not find the book useful, especially to put in the hands of beginning students. The illustrations, many of which are colored, are very good and well selected, the great majority original, from drawings by Mrs. Beutenmuller. Unfortunately the publishers have failed entirely to number the colored plates but as all the figures have the names appearing beneath them this omission is not so bad as it might have been.

C. T. B.

A YEAR OF COSTA RICAN NATURAL HISTORY. Calvert, A. S. and P. P. Calvert. Octavo, pp. 577, with numerous half-tone illustrations and map. The Macmillan Co., New York, 1917.

Although this is a general account of Costa Rican natural history, its writers are particularly interested in dragon-flies, and the book is in quite considerable part entomological. Aside from a description of the country and its people as observed by the writers during their visit, there are notes on the fauna and flora illustrated by a series of good photographs and a large number of observations on insects other than Odonata. The writers were in Cartago at the time of the destructive earthquakes of May, 1910, but fortunately escaped injury and were able to save the collections they had made.

The book gives an idea of the entomological possibilities of Costa Rica and should be of interest to entomologists or others planning to visit this country as well as to those expecting to journey in other parts of the American tropics for the first time.

C. T. B.

EXCHANGE COLUMN.

Notices not to exceed four lines in length concerning exchanges desired of specimens or entomological literature will be inserted free for subscribers, to be run as long as may be deemed advisable by the editors.

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ON THE EXISTENCE OF IMMUNITY PRINCIPLES IN INSECTS.¹

BY R. W. GLASER.

During the course of my work on various diseases of insects, I have often been confronted by results which seemed to point towards the existence of immunity principles. I failed to become convinced, however, till I instituted a series of experiments meant to prove or disprove my views. Other workers, also, on investigating caterpillar and grasshopper diseases, have been unable to explain some of their results without assuming the possibility of physiological immunity, but direct proof for their contentions has been lacking.

In physiological work of this sort it is very difficult to obtain quantitative data for the reason that the amount of blood obtainable from a particular insect amounts to only one-tenth to one-fifth of a cubic centimeter. In one series of experiments I managed to obtain quantitative results. The other data are qualitative but, I hope, no less important.

THE QUESTION OF PHAGOCYTOSIS.

Since all entomological text-books emphasize the importance of the blood cells in ridding the insect body from the invasion of foreign substances this question was first investigated. In practically all the literature on the subject, insect blood cells are compared with the mammalian white blood corpuscles. An exceedingly aggressive nature is attributed to them and their movements are described as actively amæboid, engulfing foreign substances with great avidity. I was greatly astonished to find that this view was incorrect and that the blood cells are visibly rather passive. Of course, we know that the so-called amæbocytes play an important rôle during metamorphosis, and I do not wish to create the

¹ Contribution from the U. S. Bureau of Entomology in coöperation with the Bussey Institution of Harvard University. (Bussey Institution, No. 143.)

impression that I depreciate the importance of these cells. However, even during metamorphosis their action is not confined to an aggressiveness manifested by movement but rather, I think, to an increase in the secretion of proteolytic and perhaps other enzymes. These break down the larval tissues and prepare the various proteins and other substances for assimilation by the imaginal disks that form the adult tissues.

One gains the impression from text-books that the insect blood cells, called amæbocytes, during metamorphosis, bodily attack those larval tissues destined to destruction; that they swallow masses of such tissues, digest them and then wander over to the imaginal disks where they surrender the digested matter. I will attempt to show that insect blood cells are not quite as aggressive, as we have been persuaded to suppose, and that one can stimulate the formation of certain substances acting extracellularly. It may be true that these substances are formed by the cells but, on the other hand, it is also possible that they are formed by the blood plasma or serum. After they are formed, however, they act independently of any cellular organization.

During 1916 and 1917 while studying certain bacteria pathogenic to caterpillars, and others pathogenic to grasshoppers, I had occasion to inoculate many insects with different cultures. In some of my experiments several of the insects lived in spite of the fact that enormous numbers of microorganisms, supposedly pathogenic, were introduced. For example: Ten mature female grasshoppers (*Melanoplus femur-rubrum*) were each injected with $\frac{1}{10}$ c.c. of a 24 hour bouillon culture of *Bacillus poncei* Glaser. *B. poncei* is a highly motile organism which I obtained from the Honduran government in 1915. The bacterium is ordinarily pathogenic to *M. femur-rubrum*. After intervals of $\frac{1}{2}$, 1, 2, and 24 hours the animals were killed and a large metathoracic leg removed from each by breaking the joint between the trochanter and femur. The blood that oozed from each animal was caught on a separate sterile cover-slip. Some of these preparations were fixed by passing through a Bunsen flame, others were immersed in 70 per cent. alcohol, while still others were fixed with Schaudin's corrosive sublimate solution. After fixation, the preparations were dried and stained with methylene blue. Excessive staining can be remedied, of course, by treatment with alcohol. After mounting

the preparations were studied and I was astonished to find that they were surprisingly free from *Bacillus poncei*. Six of the smears showed no microorganisms whatever, the remaining ones showed a few bacilli scattered about here and there outside of the blood cells. On examining each smear carefully by studying ten fields with the oil immersion lens, I found only one blood corpuscle with *B. poncei* embedded in its cytoplasm. If the grasshoppers had been permitted to live, I feel sure that only the four revealing any bacteria in the blood would have finally died of the disease. The remaining six would have lived till they succumbed to natural causes. Two animals were examined after $\frac{1}{2}$ hour; two after 1 hour; two after 2 hours and four after 24 hours. The bacteria were found in one case examined after $\frac{1}{2}$ hour, in two examined after 2 hours and in one examined after 24 hours. This experiment was repeated with similar results.

In many of the inoculation experiments with *B. poncei* from one-fourth to one-half of the animals did not die and I then assumed that the blood acted antagonistically towards the introduced bacteria. The blood tests cited above seemed to be evidence in favor of this view. The blood of a certain number of the inoculated animals managed to rid itself of *B. poncei* and, moreover, this riddance was not accomplished by hungry amœbocytes as the textbooks would have us believe. If the grasshopper blood cells had phagocytised large numbers of the bacteria I surely would have noticed this in the stained smears. In some cases the blood, however, acted antagonistically towards the bacteria and I will later show more clearly that the antagonistic substances are extracellular and therefore in the blood plasma or serum.

I thought that the tissue culture method might offer some interesting possibilities in studying, *in vitro*, the behavior of insect blood cells towards bacteria. The method for preparing such cultures is very simple and does not differ materially from the well known methods used by Harrison, Carrel, etc. for the cultivation of embryonic mammalian tissue. I shall not describe a method familiar to all biologists.¹

The results of the following four experiments may be considered characteristic for a large series performed with both grasshopper

¹ Those interested in the cultivation of insect blood cells may be referred to R. W. Glaser: "The Growth of Insect Blood Cells in Vitro." *PSYCHE*, Vol. XXIV, No. 1, 1917.

and army worm blood. The blood of *Melanoplus atlanis* was used for these four experiments and *Coccobacillus acridiorum* d'Herelle, pathogenic to grasshoppers, was the organism used for the artificial contamination of two of the four tissue culture slides. Two slides were considered as checks. They were prepared by mixing a drop ($\frac{1}{10}$ of a c.c.) of the grasshopper blood with a drop of sterile, neutral, nutrient bouillon. The first day all of the blood cells appeared perfectly normal. On the third day some showed signs of disintegration, whereas others remained normal. On the sixth day the cells destined to disintegrate were completely disorganized. The others remained normal and showed cell division with the formation of syncytial, tissue-like masses. After two weeks the cells still appeared normal and the syncytia had increased considerably in size. The observations were not continued after two weeks. Throughout the entire period the slides had remained perfectly sterile showing that all technical precautions, observed during their preparation, had been adequate. At no time, not even during the first day before the formation of fibrin, did I observe any independent movement on the part of the blood cells. They remained passive and the only visible independent activity observed consisted in cell division on and after the sixth day.

The two experimental slides were prepared by mixing a drop of the grasshopper blood with a platinum loop-full of a 24 hour culture of the *Coccobacillus acridiorum* d'Herelle, a highly motile organism. The slides were examined as soon as prepared. The blood cells appeared to be perfectly normal and remained entirely passive. The preparations were swarming with the motile bacteria and in ten to twenty minutes many of the bacteria made their way into the cytoplasm of the blood cells. The latter did not engulf the bacteria which seemed to bore their way into the cytoplasm.¹ On the third day the bacteria were no longer motile. They seemed to be multiplying, but appeared in bunches simulating agglutination masses. Some of the blood cells had disintegrated; others appeared perfectly normal and bacteria were no longer visible within the cytoplasm. On the sixth day the bacteria seemed to be in about the same condition; multiplying, bunched and

¹ This may have been due to surface tension. It may be called phagocytosis if the word is used in a broad sense.

motionless. The blood cells showed cell division and the formation of the tissue-like, syncytial masses. Bacteria were not found within the cytoplasm of any of the cells. In two weeks the two culture slides presented much the same condition with the exception of the blood cell syncytia which were much larger. The observations were discontinued after two weeks.

The foregoing experiments were repeated with army worm and gipsy moth caterpillar blood. The results were in perfect harmony with the grasshopper blood observations.

From the tissue culture work, we are forced to conclude that in a mixture of insect blood cells and bacteria, the blood cells are not the visible aggressors. However, the blood seems to be able to overcome bacterial invasion to a certain extent. Substances are elaborated which antagonize the bacteria. On the culture slides, the quantity of the blood is not sufficient, and metabolism is lowered, so that antagonistic substances are not formed so rapidly nor so abundantly as is the case within the body of the insect. For this reason, although the bacteria were rendered ineffective on the culture slides and permitted the blood cells to grow, they were not killed. All of these questions will be more clearly elaborated in the next section.

EXTRACELLULAR ANTAGONISTIC SUBSTANCES.

In a large series of experiments with grasshoppers (*Melanoplus femur-rubrum*) and *Bacillus poncei* four animals remained alive after two weeks. These animals, like the remainder, which died, had been injected with $\frac{1}{10}$ of a cubic centimeter of a 24 hour bouillon culture of *B. poncei*. I suspected that these four animals were immune and thought it might be possible to demonstrate the existence of some immunity principle, such as an agglutinin. Of course, on account of the small amount of blood obtainable from a grasshopper, it is extremely difficult to perform a Widal test with all the high dilutions, but I am confident that my experiments are significant in spite of this shortcoming.

Four depression slides were prepared from the four supposedly immune animals. A leg from each grasshopper was broken and a drop of blood from each was caught on a separate sterile cover-slip. To each cover-slip I added one platinum loop-full of a 24 hour bouillon culture of *B. poncei*. The culture was first examined

microscopically and the organisms were found to be highly motile. The cover-slips were kept under observation and at first the bacteria swarmed about everywhere at an exceedingly lively rate. The motility seemed to diminish in a few minutes and in 20 minutes to $\frac{1}{2}$ hour the bacteria had agglutinated in large masses and seemed to be dead to all appearances. The four tests were identical and I never saw a better reaction with *Bacillus typhosus* and typhoid serum.

Four depression check slides accompanied the four used in the experiment. These were prepared by adding *B. poncei* to normal *Melanoplus femur-rubrum* blood. The bacteria remained motile till the next day.

The eight slides were prepared under sterile conditions and the edges of the coverslips sealed with sterile vasalene, so that I was able to keep them for six days. At the end of that time when I examined the preparations the agglutination masses presented the same appearance in all four experimental slides. The blood corpuscles, however, had divided and formed syncytia. I inoculated culture tubes from these four slides, but obtained no growth, proving that all the bacteria had been killed. The four check slides proved to be interesting in a different way. On them the bacteria were not motile, but long chains were visible showing life. In some places the bacteria were bunched, but no true agglutination masses were found. On check slide 4 the blood showed signs of growth through the formation of syncytia. The blood corpuscles seemed not to have grown on the other three preparations. Culture tubes were inoculated from these check slides and pure cultures of *B. poncei* were obtained from all.

I thought it would be interesting to obtain some quantitative data in regard to the bactericidal action of immune insect blood. Sixteen *M. femur-rubrum* grasshoppers were injected each with $\frac{1}{10}$ c.c. of a 24 hour bouillon culture of *B. poncei*. In ten days all but three had died, and since no deaths were recorded for four days I assumed that the three living animals had acquired immunity against the bacteria. Small samples of blood removed from each showed no bacteria microscopically. Under sterile conditions the following experiments were performed in small test tubes. Adequate checks accompanied the series.

Experiments.

- (1) 2 drops¹ ♀ *femur-rubrum* immune blood + 1 c.c. bouillon + 1 loop of *B. ponci*.
 (2) 2 drops ♀ *femur-rubrum* immune blood + 1 c.c. bouillon + 1 loop of *B. ponci*.
 (3) 2 drops ♂ *femur-rubrum* immune blood + 1 c.c. bouillon + 1 loop of *B. ponci*.

Checks.

- (1) 2 drops bouillon + 1 c.c. bouillon + 1 loop of *B. ponci*.
 (2) 2 drops ♀ *femur-rubrum* normal blood + 1 c.c. bouillon + 1 loop of *B. ponci*.
 (3) 2 drops ♂ *femur-rubrum* normal blood + 1 c.c. bouillon + 1 loop of *B. ponci*.

The six test tubes were incubated for 24 hours at 35° C. At the end of that period neutral potato agar plates were poured from the six cultures using the customary one, two, and three dilution method. Each experiment and each check was represented by three plates making eighteen plates altogether. They were incubated for three days at 35° C. after which a count was made of the developed colonies. The colonies on the six first dilution plates (experiments and checks) were too numerous and confluent for counting. Those on the six second dilution plates were also extremely numerous. At a glance one could tell that the colonies on the check plates were more numerous than on the experimental plates. By taking counts of sections of all the plates I arrived at the conclusion that the ratio of check to experimental colonies was about 10: 1.

With the six third dilution plates I was able to make actual colony counts for the three experiments and three checks.

NUMBER OF COLONIES ON THIRD DILUTION PLATES.

<i>Checks.</i>	<i>Experiments.</i>
(1) 7	0
(2) 4	0
(3) 6	0

As can be seen from the foregoing table Checks 1, 2, and 3 gave 7, 4, and 6 colonies respectively, whereas nothing at all was obtained on the three third dilution experimental plates.

These experiments taken in conjunction with the other results I have presented show that it is possible to bring about the formation of bacterioidal properties in some insects. From my tissue culture work discussed under phagocytosis, I have shown that normal insect blood is somewhat antagonistic towards bacteria,

¹ Two drops equals 1/5 of a cubic centimeter. This is the maximum amount of blood which one can obtain from one animal at a time.

but this antagonism is much more evident in animals that do not die after a bacterial infection, i. e., animals which are immune.

If it were only possible to inject an insect more than once without producing fatal results, I am sure one could obtain still more interesting results. I have often made two trials but grasshoppers and caterpillars, at least, do not seem able to overcome the effects of a second injection.

SUMMARY.

1. Entomological text-books emphasize the importance of phagocytosis in ridding the insect body of foreign matter, but in reality insect blood cells are visibly rather passive.

2. Grasshopper and caterpillar blood cells do not seem to phagocytise bacteria in an amœboid fashion.

3. When bacteria are found within the blood cells, they may have gained entrance through their own aggression or physical factors may have been involved.

4. The blood of normal insects, however, is somewhat antagonistic towards bacteria.

5. This antagonism acts extracellularly.

6. Actively immunized grasshopper blood shows a high degree of antagonism towards the bacteria used in producing this immunity.

7. An agglutinin was found in immune grasshopper blood.

8. Some quantitative data on the bacteriacidal action of immune grasshopper blood were obtained.

LIPEURUS DOVEI *NOM. NOV.*

E. A. MCGREGOR.

Bureau of Entomology, U. S. Department of Agriculture.

It was recently brought to my attention by Dr. A. Hassall through Dr. L. O. Howard that in naming *Lipeurus lineatus*¹ I have used a preoccupied name.² Therefore, as a substitute for *L. lineatus* I propose, as above recorded, the name *L. dovei*, in honor of Mr. W. E. Dove of the Bureau of Entomology who has been instrumental in collecting several new and interesting species of Mallophaga.

¹ PSYCHE, Vol. 24, No. 4, p. 114, 1917.

² Zeitsch. f. Ges. Naturw., Vol. 28, p. 384, 1866.

THE GENITALIA AND TERMINAL ABDOMINAL STRUCTURES OF MALE NEUROPTERA AND MECOPTERA WITH NOTES ON THE PSOCIDAE, DIPTERA AND TRICHOPTERA.¹

BY G. C. CRAMPTON, PH.D.

Since the Neuroptera form one of the most important groups for a phylogenetic study of the higher insects, the discussion of the condition met with in them, and in the closely allied Mecoptera, is here offered as the basis of a later, more detailed consideration of the genitalia of the Trichoptera, Diptera, and other higher forms which can be more profitably taken up in separate articles, and are therefore only briefly referred to in the present paper. The homologies here proposed are based upon a more extensive consideration of the genitalia of the males of the lower insects, published in the June, 1918 issue of the Bulletin of the Brooklyn Entomological Society, and forms one of the series of phylogenetic studies there listed.

Many of the accompanying rough sketches were made from material kindly loaned by Mr. Nathan Banks, to whom I am likewise indebted for identifications of specimens, and for the loan of valuable literature dealing with the subject. Dr. R. J. Tillyard has also furnished me with a number of intensely interesting Neuroptera for study, in addition to much valuable literature on Australian Neuroptera and Mecoptera. Since I have been largely dependent upon the generosity of others for material in carrying on the present investigation, I would make use of this opportunity of acknowledging my deep obligation and expressing my very sincere gratitude to Mr. Banks and Dr. Tillyard for their ready and generous response to a request for aid in furnishing material and literature for such a study.

It is indeed surprising that so little has been published concerning the homologies of the genitalia of male Neuroptera and Mecoptera, which are of the utmost importance for the correct interpretation of the parts in the higher forms. Since those who have referred to the genitalia of the groups in question have, for the

¹ Contribution from the Entomological Laboratory of the Massachusetts Agricultural College, Amherst, Mass.

most part, contented themselves with merely describing the parts, without comparing them with other insects, the homologies here proposed must be regarded as purely provisional, until more intermediate stages can be obtained in order to determine what paths of development have been followed in arriving at the different types of genitalia here represented, or until suitable material can be obtained for dissections which cannot be carried out with dried, borrowed material, or from single specimens, upon which I have been largely dependent! On this account, it is to be hoped that those who have specialized in these groups, and therefore have access to a wider range of forms and more favorable material, will carry out a more extensive study of the genitalia, in order to arrive at a definite conclusion concerning many of the points which a lack of suitable material has made it impossible to determine.

It is quite generally conceded that the Sialid group should be rated among the most primitive representatives of the order Neuroptera.¹ I have therefore selected *Corydalid*, *Chauliodes* and *Neuronia* (which are the most instructive representatives of the group, available to me) as the basis for a comparison with the higher forms here discussed. In these insects (Figs. 4, 10, and 15), the digestive canal opens through an anal tubercle called the *tuberculum*, *anopilla*, or *proctiger* "ap." The two plates labeled "pa," one on either side of the tubercle "ap," were called *paraprocts* in a previous discussion of the parts in Neuroptera (Crampton, 1918), although I am not positive that they are the exact homologues of the paraprocts, or parapodial plates, of the Orthoptera and lower insects. In *Corydalid* (Fig. 15), the plate "pa" bears a pair of appendages "g," usually referred to as the *superior* and *inferior appendages of the gonopods*. For the sake of brevity they may be termed the *surgonopod* and *subgonopod*. The upper appendage, or surgonopod (Fig. 15) is the larger of the two, and appears to be the one to persist, when one of the two appendages is lost (as in Fig. 10, etc.).

Klapalek, 1903 (Bull. Int. Acad. Sci. Bohême), thinks that the gonopods of adult Trichoptera, etc. correspond to the "*Nachschiebern*" (anal prolegs?) of the larva. The gonopods of Neu-

¹ A study of the thoracic sclerites (which offer the most important characters for determining the relationships of insects) would indicate that the Neuroptera form a homogeneous group, which should not be further divided into "orders."

roptera, Mecoptera, etc., are usually homologized with the so-called "gonopods" of the Ephemera (Fig. 6, "s"), but, as was pointed out in a previous paper (Crampton, 1918), the structures labeled "s" in Fig. 6 of the Ephemera, are in reality *styli* which are segmented (*arthrostyles*) in some forms, and are composed of a single segment in others. The segmented styli (*arthrostyles*) labeled "s" in Fig. 6 of the Ephemera are borne on the plate "hy" situated *below* the male genitalia, and therefore cannot be homologous with the gonopods "g" of Figs. 10, 15, etc., which are situated *above* the male genitalia, and are not borne on the plate "hy," so that I have retained the term "gonopods" for the structures labeled "g," in Figs. 10, 15, etc., and have applied the designation "arthrostyles" to the segmented styli of the Ephemera.

The so-called "*mammilliform processes of the penis*," labeled "pu" in Fig. 15, and described by Van der Weehle (Megaloptera, Coll. Baron de Selys Longchamps) in *Corydalis*, etc.; may possibly be homologous with the structure called the titillator by Brunner von Wattenwyl, 1876, in the Orthoptera, since the structures in question are situated above the opening of the ejaculatory ducts in *Corydalis*, etc. (as is the case in the Orthoptera). The structures labeled "pu" in Figs. 4, 10, etc., on the other hand, are possibly homologous with the so-called penis hooks, or "*penunci*" of lower forms. For the sake of convenience, however, all the structures labeled "pu" are here referred to as "penis hooks," regardless of their position with reference to the opening of the ejaculatory ducts.

Ventral to the penis hooks "pu" of *Chauliodes* (Fig. 10) is a cylindrical column-like structure "co" called the *columna* in a previous discussion of the parts in Neuroptera (Crampton, 1918). Below this is the so-called *genital valve* "hy," which is homologous with the *hypandrium* or *subgenital plate* of the lower insects. In the lower forms, the plate "hy" of the males frequently bears a pair of styli; but I have been unable to find these in any of the Neuroptera or Mecoptera thus far examined. The lobe-like structure situated above the plate "hy" and labeled "sl" in Fig. 15, may possibly be homologous with the so-called *sublobi* of lower insects (Crampton, 1918).

In the Psocid shown in Fig. 17, there is a *supraanal plate* or *epiproct* "sa" situated above the anal opening, on either side of which is a *parapodial plate* or *paraproct* "pa." I would interpret

the callosity labeled "c" in Fig. 17, as the remains of the cercus (which appears to be lost, or vestigial in most Neuroptera), and the spine-like process "g" as the homologue of the gonopod "g" of *Chauliodes* (Fig. 10), although I am not sure that these interpretations are correct, until other material has been examined to determine these points. The Psocidæ seem to be as closely related to the Neuroptera as any of the lower insects, and may be regarded as annectent between the Neuroptera and the Embiid Plecopteran group, from which have also branched off the Isoptera to which the Psocids are likewise closely related.

It is impossible to draw any definite conclusions concerning the relationships of the different Neuropteroid insects from a study of the genitalia alone; but the following points of similarity of structure in the different groups may be noted. In the Sialid group (Figs. 2, 4, 10, and 15), the hypandrium, or subgenital valve "hy" is comparatively small, and the gonopods "g" with the paraprocts "pa" are usually represented, although they are not always well developed. The anal tubercle or proctiger "ap" is present in most of this group, while the supraanal plate is usually wanting.

Ithone (Fig. 14) is considered as one of the most primitive representatives of the Neuroptera-Planipennia, and presents certain features suggestive of the condition found in the Sialid group. In the dried specimen of *Ithone* here figured (Fig. 14) there appeared to be a somewhat shriveled anal tubercle or proctiger "ap." The structures labeled "g" in Fig. 14, are not very like the gonopods "g" of the Sialid group (Figs. 10 and 15); but resemble somewhat more closely the structures labeled "g" in the Myrmeleonidæ (Fig. 7) which have been provisionally homologized with the gonopods. The penis hooks "pu" of *Ithone* (Fig. 14) are quite unlike those of the other forms here shown, and are covered by an arched roof-like structure. The hypandrium or subgenital plate "hy" is well developed in *Ithone*, unlike the condition occurring in the Sialid group.

Polystoechotes (Fig. 8), which is one of the Planipennia, has no well developed hypandrium "hy," and a structure labeled "co" in Fig. 8, may possibly represent the columna "co" of the Sialid group (Fig. 10). If this is correct, the terminalia, or terminal abdominal structures of some Planipennia are not unlike those of certain Sialids. In *Nemoptera* (Fig. 12), another of the group

Planipennia, the hypandrium "hy" is even larger than that of *Ithone* (Fig. 14, "hy"). In *Nemoptera* there is a large columna-like structure (Fig. 12, "co") which has been homologized with the columna "co" of *Chauliodes* (Fig. 10), and in addition, a small "epicolumna" labeled "p" has been developed. The columna "co" of Fig. 12 bears two lobes at its apex, suggesting a bipartite origin for this structure, and it is possible that it may represent the united penis hooks "pu" (Figs. 4, and 10) rather than the columna "co" of Fig. 10. I have provisionally homologized the lateral plates "pa" of Fig. 12, with the paraprocts "pa" of Figs. 17 and 15; but I am not certain that this is the correct interpretation of these structures. The structures labeled "g" in Fig. 12 may not be the true gonopods, but have been provisionally homologized with them.

Nymphes (Fig. 3) is regarded as one of the least modified forms related to the Myrmeleonidæ; but it has been very difficult to interpret the parts aright in this insect, and I am by no means certain that the conclusions here reached are the correct ones. The hypandrium "hy" is well developed in *Nymphes* (Fig. 3), and the structures apparently homologous with the penis hooks, labeled "pu" in Fig. 3, are very large and bear several "prongs." The structure designated "sa" in the figure probably represents the supraanal plate (epiproct), although it may possibly be homologous with the anal tubercle instead. I have provisionally homologized the lobes "cl?" of Fig. 3 with the copulatory lobes "cl" of the Mecopteron shown in Fig. 18; but there is a possibility that they should be homologized with the plates "pa" of Fig. 17 instead. The parts of *Nymphes* (Fig. 3) are disappointingly unlike those of the Ascalaphidæ (Fig. 1) and Myrmeleonidæ (Fig. 7), although the Ascalaphidæ are very similar to the Myrmeleonidæ in having a dorsal plate "sa" (Figs. 1 and 7), which has been interpreted as the suranal plate or epiproct, and two elongate lateral processes "g" provisionally homologized with the gonopods.

Mantispa (Fig. 5) resembles *Nemoptera* (Fig. 12) in having a well developed hypoproct "hy," within which is a slender structure labeled "co" (Fig. 5), which may possibly be homologous with the structure interpreted as the columna "co" in Fig. 12. The two plates "pa" of *Mantispa* (Fig. 5) are possibly homologous with the plates labeled "pa" in Fig. 12 of *Nemoptera*.

Raphidia (Fig. 16) does not seem to be very like any of the other Neuroptera here figured so far as its terminal structures are concerned. It has an arched dorsal plate "sa" which may represent the supraanal plate, or epiproct, beneath which are two processes "g," provisionally homologized with the gonopods "g" of Fig. 10, etc. The two penis hooks "pu" of *Raphidia* (Fig. 16) are apparently homologous with the structures labeled "pu" in Fig. 5 of *Mantispa*, and the median hook "mu" of Fig. 16, is possibly homologous with the median hook "mu" of Fig. 5, although I am somewhat at a loss to account for the homologies of the structure "mu" of Figs. 5 and 16, in other forms.

The Coniopterygidæ (Fig. 11) are too small and highly specialized for one to be able to make very much out of a study of their parts. The hypandrium "hy," of Fig. 11, is comparatively well developed, and the structures labeled "pu" appear to represent the penis hooks "pu" of the other Neuroptera. The terminal structures of the Coniopterygidæ appear to resemble those of the Planipennia, as much as any other Neuroptera.

Turning next to the consideration of the genitalia and terminalia of the Mecoptera, we find two types represented, namely, those with forceps-like gonopods (*e. g.*, Figs. 24, 20, 23, 27, and 28) which are of extreme length in *Merope* (Fig. 24 "g"), and a second type represented by the *Bittacus*-group (Figs. 18 and 22) in which the gonopods are not developed in the form of forceps-like structures. In Vol. 27, page 298 of the *Entomological News* for July, 1916, I suggested that the *Merope* type of Mecoptera represented a suborder called the "Promecoptera," in which the wings present a very primitive venation, the head is not greatly elongated, etc. *Merope*, however, is quite closely allied to the other members of the *Panorpa*-group, and should be included in it, so that there are but two principal groups of living Mecoptera (the *Bittacus*-type and the *Panorpa*-type) and these two might be considered as representing two suborders of the Mecoptera, although they are more probably of merely superfamily rank. Tillyard, 1917 (Proc. Linn. Soc. N. S. Wales, 42, p. 188), applies the term Promecoptera to a new order of fossil insects which in certain respects resemble the ancestors of living Mecoptera.

Although I feel certain that such forms exist, I have been unable to find any Neuroptera in which the gonopods are in the form of

jointed forceps-like structures as in the *Panorpa*-group (Figs. 24, 23, etc.), and since the *Bittacus*-group seems to be as primitive as any, so far as the terminal structures and genitalia are concerned, I have used them as the basis for a comparison with the other Mecoptera and the Neuroptera. *Bittacus* (Figs. 18 and 22) seems to resemble *Nymphes* (Fig. 3) as much as any Neuroptera, in respect to its terminal structures; and the median terminal appendage "sa" of Figs. 18 and 22, which is either homologous with the supraanal plate (epiproct) or with the anal tubercle (proctiger), is apparently the homologue of the median terminal structure labeled "sa" in Fig. 3 of *Nymphes*. The copulatory claspers "cl" of *Bittacus* (Figs. 18 and 22) are possibly represented by the lobes labeled "cl?" in Fig. 3 of *Nymphes*, and are analogous to, if not actually homologous with, the copulatory claspers, "cl," of the Phasmid shown in Fig. 9, and doubtless had a similar origin. The claspers "cl" are very large in *Bittacus strigosus* (Fig. 18); but are much smaller in *Bittacus pilicornis* (Fig. 22). Correlated with the greater development of the claspers "cl" of *Bittacus strigosus* (Fig. 18), there is a greater development of the appendages labeled "c" (which are provisionally homologized with the cerci) than in *Bittacus pilicornis* (Fig. 22), although in the latter insect, the median appendage "sa" is proportionately somewhat larger than that of *B. strigosus* (Fig. 18). In both insects shown in Figs. 18 and 22, there occurs a pair of closely approximated hooks labeled "pu," provisionally homologized with the penis hooks. Between them there projects a spiral thread or spirofilum "sf," wound like a watch spring. It is possible that this spiral thread represents the columna "co" of Fig. 10. At the base of the hooks "pu" (Figs. 18 and 22) is a pair of appendages labeled "g?" which may represent the gonopods of the other Mecoptera, although I would not insist upon this interpretation. Miyake, 1913, on the other hand, regards the hooks "pu" (Figs. 18 and 22) as parts of the "pedes genitales."

In comparing the *Panorpa*-group with the *Bittacus*-type, one of the most noticeable features is the lack of development of the claspers "cl" in the former group. On the other hand, the gonopods "g" are greatly developed in the *Panorpa*-group (Figs. 24, 20, 23, and 27). I am not sure that the distal segment of the gonopod "g" of Fig. 23 is homologous with the appendage labeled

"g?" in Fig. 18, since it may correspond to the structure labeled "pu," instead; but I have provisionally adopted the interpretation indicated by the labeling. In most of the *Panorpa*-group there are one or two pairs of dorsal valvæ (dorsovalvæ), "dv" of Figs. 21, 23, 24, etc., and a pair of ventral valvæ (ventrovalvæ), "vv" of Figs. 23, 26, etc., and it is possible that certain of these valvæ may represent the penis hooks of Neuroptera, etc.

The anal tubercle "ap" of Fig. 21, bears at its base a pair of appendages "c" whose location suggests that they are homologous with the so-called cerci "c" at the base of the median terminal structure "sa" of Figs. 18 and 22. On this account, I would consider the structure "ap" of Fig. 21 as homologous with the structure "sa?" of Figs. 18 and 22, although I am not certain whether the structure labeled "sa?" in Figs. 18 and 22 is the epi-proct "sa," or the proctiger "ap," of other insects. Tillyard describes a pair of segmented cerci in *Nannochorista* (Fig. 28, "c"), which appear to be homologous with the structures labeled "c" in Figs. 21, 23, etc., and on this account I have interpreted the latter structures as the cerci. I am not certain of the correctness of my interpretation of the structures labeled "c," as the cerci, and the structures labeled "dv," as the dorsal valvæ, in Fig. 24 of *Merope*; but have provisionally adopted this method of homologizing them. The projecting ventral process "co" of Fig. 26, may be homologous with the columna, and if the latter is represented by the coiled filament "sf" of Figs. 18 and 22, the structure labeled "co" in Fig. 26 is doubtless to be homologized with the coiled filament "sf" also.

The phallus "pe" is large and prominent in *Boreus* (Fig. 20), and the hypandrium "hy" is well developed in this insect. In *Panorpodes* (Fig. 27) the structure which is here interpreted as the hypandrium "hy" shows a marked tendency to become long drawn out and furcate, although the cleft at its apex is not very deep. In the Panorpid shown in Fig. 26, however, the hypandrium "hy" is deeply cleft, and the two arms of the fork are comparatively long and narrow. The character of the hypandrium fork, the valvæ, etc., should be as valuable features for the purpose of classification as any structures, and it is surprising that they are not more employed in taxonomic keys.

The gonopods "g" of the Mecoptera here figured are composed of two segments. The basal one "pa?" of Fig. 23 may possibly

correspond to the paraprocts "pa" of the Neuroptera (Fig. 15, "pa"), although the elongate basal segment "g" of the gonopod of the very primitive Mecopteron *Merope* (Fig. 24) is nothing like the paraprocts in character, and this casts some doubt upon the supposition that the basal segment of the gonopods of the Mecoptera in general corresponds to the paraproct.

As was mentioned above, it is very strange that no Neuroptera have been described in which the gonopods are of the type represented in *Merope* (Fig. 24, "g") which is a very primitive Mecopteron in many respects, since the tendency toward the development of forceps-like gonopods occurs in many Mecoptera, Diptera, Trichoptera and other forms descended from Neuropteroid-like forebears. The gonopods "g" of such Mecoptera as *Merope* (Fig. 24) are apparently the prototypes of those found in certain Diptera such as the Chironomid *Clunio* (Fig. 25, "g"). The occurrence of this type of gonopod in the Diptera lends further weight to the view that the Mecoptera are very like the ancestors of the Diptera.

Some Trichoptera have well developed gonopods, such as those of *Philopotamus* (Fig. 30, "g"), as might be expected from other evidence that the Trichoptera are rather closely related to the gonopod-bearing Mecoptera, both groups having apparently descended from Neuropteroid ancestors. The structures labeled "cl" occurring on either side of the supraanal plate "sa" of *Philopotamus* (Figs. 30 and 13) resemble cerci in some respects; but have been provisionally homologized with the clasper lobes "cl" of other forms. Klapalek, 1903, refers to similar appendages in the Trichoptera as the "appendices præanales."

As far as the relationships of the orders here discussed are concerned, I would maintain that the Neuroptera, Mecoptera, Diptera, Trichoptera and Lepidoptera constitute a superorder, the *Panneuroptera*, certain of whose members exhibit a tendency toward the formation of hairs or scales on the wings (*e. g.*, certain Myrmeleonids, a few Panorpid, the Psychodid Diptera, etc., in addition to many Trichoptera, and most Lepidoptera), and in most of which the meso-thoracic coxæ, at least, are divided into a veracoxa and merocoxa (see Crampton and Hasey, 1915, "The Basal Segments of the Leg in Insects;" Zoöl. Jahrb., Abt. Anat., 39, p. 1-), the mesothoracic and meta-thoracic coxæ are usually

approximated, there is usually a sternal fulcrum of the coxa (Crampton and Hasey, l. c.), and other characters showing that they have much in common.

I would group the Psocidæ, Thysanoptera, Mallophaga, Anoplura (Pediculidæ), Hemiptera and Homoptera in another superorder, the *Panhomoptera*, but by so doing, I would not minimize the close relationship of the Psocids to the Neuroptera, and the close approach of the Hemipteroid lines of development to those of the Mecoptera and Diptera. The Hymenoptera are closely allied to both the Psocidæ and the Neuroptera, and I have been unable as yet to determine in which of the two superorders they should be placed.

In connection with the discussion of the interrelationships of the orders of insects, it may be of some interest to note that it would appear that in the interesting little Crustacean *Bathynella* we have a form very like the common ancestors of the Insecta and "Myriopoda" (*sensu lato*). *Bathynella* belongs to a very ancient group of Crustacea, and the number of segments composing its body, the character of its appendages (which are lacking on the last segments), etc., are all in accord with the view that it is very like the ancestors of the Proturan insects. *Bathynella* is also very like the probable ancestors of the Symphyla-Pauropoda, a group which has departed but little from the condition characteristic of the ancestors of the "Myriopoda" as a whole.

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See also articles by Banks, Tillyard, and other systematic articles on Neuroptera and Mecoptera.

ABBREVIATIONS.

- | | |
|---|---------------------------------------|
| ap = Anal tubercle; anopapilla, or proctiger. | g = Gonopods, or their homologues. |
| c = Cerci, or vestiges of cerci. | hy = Subgenital valve, or hypandrium. |
| cl = Copulatory lobes, or copulobi. | mu = Median hook, or mediancus. |
| co = Columna. | sa = Supraanal plate, or epi-proct. |
| dv = Dorsal valvæ, or dorso-valvæ. | sf = Spiral filament, or spirofilum. |
| pa = Parapodial plates, or paraprocts. | sl = Sublaminæ. |
| pe = Phallus. | t = Terminal filament, or telofilum. |
| pr = Preepiproct. | vv = Ventral valvæ, or ventro-valvæ. |
| pu = Penis hooks, or penunci. | |
| s = Jointed styli, or arthrostyles. | |
| ep = Epicolumna. | |
| f = Pendent filaments. | |

EXPLANATION OF FIGURES.

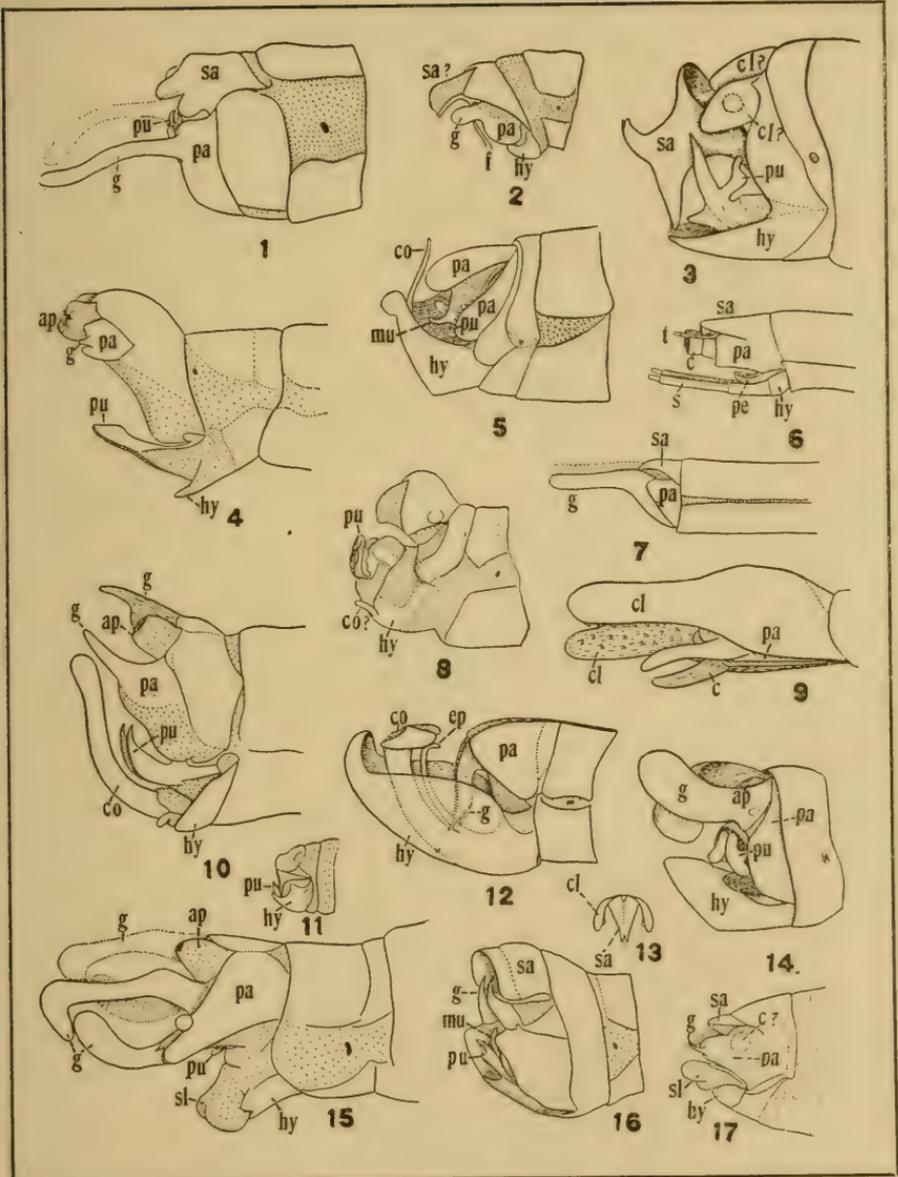
Unless otherwise stated, figures are of terminal structures and genitalia.

Plate II.

- Fig. 1. Lateral view of an Ascalaphid (Neuroptera).
 Fig. 2. Lateral view of *Sialis* (Neuroptera).
 Fig. 3. Lateral view of *Nymphes myrmeleonides* (Neuroptera).
 Fig. 4. *Nigronia serricornis*, Say (Neuroptera), lateral view.
 Fig. 5. *Mantispa brunnea*, Say (Neuroptera), lateral view.
 Fig. 6. *Ephemera varians?* (Ephemeridæ), lateral.
 Fig. 7. *Brachynemurus longicaudus*, Br. (Neuroptera), lateral view.
 Fig. 8. *Polystachotes punctatus* Say (Neuroptera), lateral view.
 Fig. 9. *Clitumnus lævigatus*, Br. (Mantidæ), lateral.
 Fig. 10. *Chauliodes pecticornis*, L. (Neuroptera), lateral.
 Fig. 11. A Coniopterygid (Neuropteran), lateral.
 Fig. 12. *Nemoptera sinuata* (Neuroptera), lateral. Restored from crushed specimen.
 Fig. 13. *Philopotamus* sp. n (?) (Trichopteron), dorsal view of lobes and suranal plate.
 Fig. 14. *Ithone*, sp. (probably *I. fusca*), Neuropteran, lateral view.
 Fig. 15. *Corydalis cornutus*, L. (Neuroptera), lateral.
 Fig. 16. *Raphidia oculata*, Banks (Neuroptera) lateral.
 Fig. 17. Lateral view of a Psocid, probably *Psocus venosus* Burm. It is a large winged form found in colonies on pines near Amherst, Mass.

Plate III.

- Fig. 18. *Bittacus strigosus*, Hag. (Mecoptera), lateral.
 Fig. 19. *Panorpodes* (Mecopteron) from N. Carolina, dorsal view of apex of genital segments.
 Fig. 20. *Boreus brumalis*, Fitch (Mecoptera), lateral.
 Fig. 21. *Panorpa lugubris*, Swed. (Mecoptera) dorsal view of genital segments, the upper plate "pr" of Fig. 23 removed, and anal tubercle bent back.
 Fig. 22. *Bittacus pilicornis*, Westw. (Mecoptera), lateral.
 Fig. 23. *Panorpa lugubris*, Swed. (Mecoptera) lateral.
 Fig. 24. *Merope tuber*, Newm. (Mecoptera) dorsal.
 Fig. 25. *Chunio bicolor*, Kieffer (Diptera), based on Fig. 1, Plate 4, of fascicle 42 on Chironomid Diptera, by Kieffer, 1906 (Genera Insectorum).



CRAMPTON—Genitalia and Terminal Abdominal Structures.

- Fig. 26. *Panorpa nebulosa*, Westw. (Mecoptera), ventral.
Fig. 27. *Panorpodes* of Fig. 19, ventral.
Fig. 28. *Nannochorista dipteroides*, Tillyard (Mecoptera), dorsal view, based on Fig. 11 of Plate XVII, by Tillyard, 1917 (Proc. Linn. Soc. N. S. W.).
Fig. 29. *Merope tuber*, Newm. (Mecoptera), ventral. Gonopods cut off.
Fig. 30. *Philopotamus* Sp. n.? (Trichoptera), lateral.
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NOTES ON *TRIOZA ALACRIS* FLOR IN NEW JERSEY.

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This Psyllid, which was introduced into New Jersey from Belgium and which is well known and destructive in Europe, has already been recorded as occurring in New Jersey (Weiss, Canadian Ent. Feb., 1917, pp. 73-75). D. L. Crawford in the Monthly Bulletin of the California State Commission of Horticulture Vol. I, No. 3, p. 86, gives an account of its presence in California together with suggestions for its control and also treats it in his Monograph of the Psyllidæ of the New World, Bull. 85, U. S. N. M.

It occurs in New Jersey on bay trees which are kept either under glass all the year or out of doors during the summer and under glass the remainder of the year. The following observations were made on trees kept outside during the summer months. Its presence on Bay (*Laurus nobilis*) can be readily detected by the curled, discolored, swollen, blistered leaves, usually at the tips of the branches, containing what appear to be whitish masses. Upon uncurling a leaf the nymphs are readily seen clothed in a white waxy secretion. In severe infestations the tree has a sickly and unwholesome appearance.

In New Jersey, the Psyllid overwinters as an adult on bay trees, which are kept in storage houses where the temperature is never allowed to go below 38 or 40 degrees F. About the middle or end of May according to the weather, the trees are moved outside and at is then when egg laying starts.

¹The arrangement of the authors' names has no significance and indicates neither seniority nor precedence.

The minute, elliptical shaped eggs are laid on the under sides of young leaves near the margins, from 25 to 200 having been found in a single, elongated, irregular cluster. The leaves containing eggs were always found to be rolled in tightly and downwardly toward the midrib. The nymphs feed within the curled leaves and during the summer all stages of the insect can be found at the same time upon the same tree showing that egg deposition evidently extends over several weeks. The nymphs are covered over with white, waxy masses excreted from their bodies. Inside of a curled leaf can also be found globules of honey dew covered over with a waxy material and in many cases colonies of mealy bugs. The last stage nymphs move out of this sticky mess just before the adult is ready to emerge and rest on a drier and cleaner portion of the leaf just beyond the pseudo-gall.

About the middle of July adults of the first brood are appearing showing that about six weeks are required for a complete life cycle. About the first of September adults of a second brood can be found. These continue to appear for a month or so longer, even as late as November when the trees are in storage, provided the weather is not cold. The cool days during the fall undoubtedly prolong the nymphal stages which are active only during warm weather and and this accounts for the delayed time over which the adults appear. These adults remain on the trees during the winter, many of them clustering around the pseudo-galls. On cold days they can be collected without difficulty on account of their dormant condition. On warm days during the winter the temperature of the storage house rises and at that time the adults are active when disturbed.

While contact insecticides are useful, it is impossible to reach the nymphs in the curled leaves which are protected still further by wax and honey dew. In New Jersey almost complete killing was secured in one case by fumigating with tobacco smoke as for aphids while the trees were in storage and heavenly infested by overwintering adults. Hydrocyanic acid gas has also been used with success (See Review of Applied Entomology, Series A, Vol. II, p. 482). It is the practice of some firms to have their men go over infested trees and pick off all curled infested leaves, but this is a slow process in a large establishment.

Egg: Length 0.2 mm., greatest width 0.1 mm. Outline oval with distal end acutely pointed, rounded at basal end. Acute

distal tip transparent, remainder opaque. Inserted in leaf tissue by means of a minute extension at basal end. One side rests close to leaf surface and becomes flattened. Other side is convex.

The following descriptions were made from alcoholic material.

First Stage Nymph: Length 0.21 mm., greatest width 0.1 mm. Color white; shape oval, broadly rounded at both ends, slightly sinuate at anterior margin; broadest across middle of thorax which gradually narrows at posterior extremity. Abdomen narrower than thorax. Body segmentation somewhat indistinct, that of abdomen indicated. Head, thorax and abdomen subequal in length. Body sparsely covered with minute hairs. Eyes indicated by red spots on lateral posterior margins of head. Antennæ length about one-third width of thorax, cone shaped, twice as long as width of base, tip slightly truncate; a minute spine arising from tip with a smaller one below. Legs, length, two-thirds the width of the thorax, gradually tapering toward tip; segmentation indistinct; apical end of leg bearing a sucker disc and a spine. Rostrum long, fine, hair-like; basal sheath extending to between bases of third pair of legs.

Second Stage Nymph: Length 0.3 mm., greatest width 0.15 mm. Color white; shape rectangular to broadly oval. Anterior end of body truncate, outer angles broadly rounded. Body gradually widening to posterior third of thorax, then gradually narrowing to posterior thoracic margin. Abdomen slightly narrower than thorax, posterior end rounded. Body sparsely hairy, segmentation indistinct. Antennæ cone shaped, length one-fifth width of thorax, outer extremity transversely ridged bearing two spines at tip. Legs similar to those of preceding stage except that they are proportionately larger and the sucker disc is missing. Tip of leg bears a pair of minute hooks. Eyes red. Basal sheath of rostrum extends to bases of second pair of legs.

Third Stage Nymph: Length 0.5 mm., greatest width 0.22 mm. Similar to second stage in shape and color except central dorsal portion of thorax and posterior margins of abdominal segments which are tinged with brown. Lateral margin of thorax bears a row of minute spines. A pair of these spines on lateral margin of each abdominal segment. Antennæ similar to those of preceding stage, length, one-sixth width of thorax. Eyes and legs similar to those of preceding stage. Basal sheath of rostrum extending to bases of second pair of legs.

Fourth Stage Nymph: Length 1 mm., greatest width 0.51 mm. Color similar to that of preceding stage. Shape oval; truncate and sinuate at middle of front; outer angles of head broadly rounded. Division between head and thorax indicated by slight indentation at lateral margin. Thorax gradually widening to posterior portion where it is broadly rounded. Dorsal surface of head and thorax covered with a shield like expansion. Wing-pads visible and extending to posterior margin of thoracic expansion. Abdomen narrow at anterior margin, broadening to anterior fourth; remaining portion broadly rounded so that abdomen is almost circular in outline. A fringe of minute spines on lateral margins of head and thorax. Several spines on lateral margin of each abdominal segment. Eyes dark brown. Antennæ broadest at base, gradually tapering to tip which is slightly truncate. Antennæ more or less transversely ridged. Apical segment is one and one-half times the length of the basal segment. Tip of apical segment bears two spines. Legs three jointed, somewhat curved. The two basal segments are subequal in width, surface of second segment slightly convex, third segment slightly convex and tapering to tip which bears a pair of minute hooks. Legs bear a few minute scattered hairs. Basal sheath of rostrum extending to bases of second pair of legs.

Fifth Stage Nymph: Length 1.7 mm., greatest width 1 mm. General shape oval. Dorsal shield like expansion of head and thorax more pronounced. Head truncate in front, slightly convex, lateral margins broadly rounded. Front and anterior dorsal portion of head bearing a number of minute spines resting on minute tuberculate bases. Lateral expanded margins of thorax abruptly rounded from sides of head. Sides of thorax moderately convex extending to posterior margin of second abdominal segment. Wing-pads extending to posterior margin of shield like expansion. Lateral margin of prothorax bears a row of minute spines each resting on a minute tuberculate base; a few scattered minute spines on dorsal surface near margin especially in the anterior region. Sides of abdomen are convex making it broadly oval in outline. Abdominal segments well defined, lateral margins of each bearing a number of minute spines resting on minute tuberculate bases. A number of very minute spines on dorsal surface near margins. Eyes prominent, lateral, covered by dorsal expansion of head.

Antennæ arising in front of eyes, apparently five jointed, length, four-fifths the width of the head; two basal segments covered by dorsal expansion of head. Antennæ transversely ridged; apical segment slightly club shaped, tapering to point and bearing two spines at tip and one on lateral margin. Legs three jointed; basal segment broadest, sides convex especially outer surface; second segment slightly longer than basal segment, sides parallel. Apical segment one-third length of second, slightly narrower; outer surface broadly rounded to inner forming tip terminated by a pair of hooks. Second and third segments bear a few scattered hairs. Basal sheath of rostrum extending to just beyond bases of first pair of legs.

Adult: Trioza alacris Flor, syn. *Trioza lauri* Targ. The following description is by Crawford (Bull. 85, U. S. N. M.). The original description by G. Flor appeared in "Zur Kenntniss der Rhynchoten Beschreibung neuer Arten der Familie Psyllodea Burm., Moskau, 1861." "Length of body 1.9 mm., length of forewing 3.2, width of head 0.71. General color greenish yellow to light brown; dorsum in darker individuals more or less striped and streaked with brown; abdomen often brown; antennæ black at tip.

"Head nearly as broad as thorax, not strongly deflexed; vertex more than half as long as broad, emarginate in front at median line, with a prominent sulcate impression on each side of median line and parallel to it; genal cones scarcely two-thirds as long as vertex, divergent, subacute, pubescent, not much depressed from plane of vertex. Antennæ about one and one-third times width of head, slender. Thorax not broad, well arched, punctate; pronotum moderately long, not strongly depressed; præscutum rather large. Legs slender; hind tibiæ with two black spines at apex on inside and one outside. Wings long, slender, transparent, fully three times as long as broad, subacute at apex; Rs short.

"Genitalia—male—Anal valve a little longer than forceps, hind margin arcuate, with long pubescence; forceps rather stout, sides almost parallel (from sides), terminating in a subacute, black point at apex.

"Female—Genital segment nearly as long as rest of abdomen, acute at apex, valves subsequial in length."

HEMIPTEROLOGICAL NOTES.

BY H. M. PARSHLEY.
Smith College, Northampton, Mass.

Anasa repetita Heidemann.

On September 19, 1917 at Northampton, Mass., I found this species in large numbers feeding on the Star-cucumber, *Sicyos angulatus* Linn. More than fifty examples, both adults and nymphs, were taken on two vines. The rarity of the species in collections is undoubtedly due to the fact that its food-plant has been unknown to collectors. I noted one example of *Anasa armigera* Say on the same plant and another in flight nearby.

Melanolestes picipes var. *abdominalis* Herrich-Schaeffer.

The forms of this Reduviid which exhibit more or less red on the abdomen are usually considered to constitute a distinct species, *M. abdominalis*, as originally described by Herrich-Schaeffer, although there seem to be no structural criteria to separate the two. Stal¹ treated *abdominalis* as a color variety (var. b) of *picipes*, but Uhler² felt that the evidence at his command did not warrant his merging them, since he never found the two forms united in copulation though both often occurred under the same stone. I have in my collection examples showing all gradations from those having only the slightest tinge of red along the connexivum to those having the abdomen entirely red; I have also a pair taken in copulation (Framingham, Mass., C. A. Frost) in which the male is an entirely black long-winged *picipes* and the female a short-winged *abdominalis*, with red connexivum. It would seem therefore that the *abdominalis* form should be ranked as a mere color variety and not as a species distinct from *picipes*, as I have done in my New England list.

The consideration of this case brings up the matter of color varieties and subspecific forms in general. In the study of some groups of insects, notably ants, the subdivisions of species are treated according to a definite system based on a relatively com-

¹ Enum. Hem. 2, 1872, p. 107.

² Hem. west of Mississippi River, Bull. U. S. Geol. & Geog. Surv. Terr., II., No. 5, 1876, p. 330.

plete knowledge of the forms, the concepts *subspecies* and *variety*, for instance, being distinct and clearly formulated. The study of the Hemiptera is less advanced, and there is usually insufficient ground for deciding whether a certain form of a species is to be considered subspecific (racial) or varietal in this strict sense. This being the case I have thus far denominated as varieties all forms of less than specific value, and have used trinomials in their designation, leaving it to be inferred that all such varieties pertain, perhaps, to the typical subspecies, as their frequently coincident ranges would seem to indicate.

Recently a tendency has become very evident to give definite varietal names not only to forms characterized by slight structural peculiarities but also to those differing only in color. Examples of the latter are to be found in the Mirid genera *Horcias*¹ and *Paracalocoris*.² Specimens of *Horcias dislocatus*, for instance, may be almost entirely black, almost entirely red, or conspicuously striped with red, black, and yellow. But a varied and more or less intergrading collection of these different forms may sometimes be taken from a single branch, and may very possibly have issued from the same batch of eggs. Thus such "varieties" represent a very different conception from the varieties of the myrmecologist, corresponding in some cases, no doubt, to his unnamed "nest-varieties," and this must be borne in mind in considering the trinomial names of Hemiptera.

As remarked by McAtee, it seems unscientific to make no attempt in collections and taxonomic treatments to separate these often totally distinct appearing forms, and if they are to be separated they should be given names for several good reasons. I have recently received communications on the subject which lead me to suggest that this matter calls for discussion with a view to bringing hemipterological concepts and nomenclature into harmony with the ideas established in the study of groups which are better understood. At present I, for one, use the term *variety* non-committally to designate subdivisions of the species (*not* aberrations) which I think should be named, but without any structural, geographic, or genetic connotation.

¹ Van Duzee, E. P. Hemipterological Gleanings, Bull. Buffalo Soc. Nat. Sci., Vol. 10, 1912, pp. 477-512.

² McAtee, W. L. Key to the Nearctic species of *Paracalocoris*, Ann. Ent. Soc. America, Vol. 9, 1916, pp. 366-390.

TRICHOPROSOPON THEOBALD (DIPTERA; CULICIDÆ).

C. S. LUDLOW.

Army Medical Museum, Washington, D. C.

Some specimens of this interesting genus from the Canal Zone bring up again the question of synonymy.

The species under consideration is quite possibly new, and as such is described below, but there is a certain amount of uncertainty on the subject arising from the following conditions. The specimens were compared with all the available descriptions and coincided with none, then they were taken to the National Museum where, what I believe to be identical specimens were found, but which H. D. & K. had referred to and described as *Culex digitatus* (*Joblotia digitatus*) Rondani, and Theobald's *Trichoprosopon nivipes* was reduced to a synonym under this species. Of course the original description by Rondani is, as are all short descriptions, too indefinite to be of much value, and Theobald's description of *nivipes* does not cover these specimens unless the note under "Observations" at the end of his description modifies it sufficiently to do so. At all events, my specimens have, in eight males, always the distal tarsal joint of the mid-legs and the apex of the fourth point, brown, as will be seen below. The specimens in the National Museum show the same condition, and the very tip of the distal joint in the female is also brown. It may be, of course, a local variation, as Theobald's specimens came from Trinidad, and mine from the Canal Zone, but Theobald speaks of his species having "pure white" joints, and it seems quite unlikely that he could have included *purely brown* under that wording. Whether the species be *digitatus* is, of course, open to question, but it seems possible that there may be some closely allied species. At all events I do not think these specimens from the Canal Zone are *nivipes*, and at the risk of adding to the synonymy I am describing these as:

Trichoprosopon Wilsoni sp. nov.

Head dark, covered with flat dark scales having deep (cobalt) blue to white iridescence, and a line of dark forked-scales at the nape, two heavy chaetæ projecting forward between the eyes and some shorter ones behind the eyes; proboscis dark, long, of uniform

width, dark highly iridescent (blue-greens to copper colored) scales, the apex at times almost white, labellæ dark; palpi dark, very slender, as long or slightly longer than the proboscis, unplumed, apical joint acuminate; antennæ light stemmed, with narrow dark bands, and heavily dark verticelled, two rows in each whorl, the slender apical joints at times appearing white; the first joint testaceous and rather heavily scaled on the median aspect; clypeus dark, heavily clothed with, and having a heavy fringe of dark hairs; eyes dark turning to copper color.

Thorax pro-thoracic lobes sub-lateral, with flat scales, probably brown, but with brilliant blue to white iridescence, and a few short dark bristles; mesonotum dark with flat closely appressed golden to bronze scales on the cephalo-laterad portion, a few dark bristles on the median line at the nape, and the rest of the mesonotum covered with dark brown spindle-shaped or broadly curved scales, and short brown bristles on the lateral margins and at the wing joints; the scutellum is light testaceous, clothed with dark flat scales having blue (cobalt) to white iridescence, six bristles on the mid-lobe and two to four (apparently variable) bristles on the lateral lobes; metanotum dark brown with a small bunch, probably about ten short, dark bristles at the median apical point and about four rows of flat scales with blue to white iridescence extending from these bristles to the base of the metanotum on the median line; pleura light, well clothed with brilliant white (silvery) small flat scales.

Abdomen covered with dark brown scales having brilliant (cobalt) blue iridescence that in some lights runs toward mauve, but seems not to lose the blue entirely at any time. There are large light golden lateral spots, rather heavier at the apex of the segments, and the same color extends on the venter which is markedly banded with dark scales on the apex of most of the segments. The apical joints are definitely bristly, and the bases of the claspers rather heavily scaled.

Legs, coxæ and trochanters light scaled, but with a narrow blue band; femora are as a whole dark dorsally, the scales having a brilliant blue to purplish iridescence, and the ventral aspect has light yellow to copper colored (or bronze) scales sometimes extending well toward the knee joint, all are heavily scaled at the apex forming a bunched effect. The remainder of the fore legs is

all dark with the brilliant iridescence found on the femur. On the mid-legs the tibiæ have the same dark iridescent scales except at the base where there is a small white spot, more easily seen on the ventral aspect; the first tarsal is dark, the second is mostly white but has a few dark scales, or they show dark reflections on the dorsal aspect, the third is also mostly white except the tip which is dark and on the dorsal side there may be a few scattered dark scales, the fourth joint is practically dark on the dorsal aspect and either whitish or ringed black and white on the ventral side, depending on the position of the light, while the fifth joint is usually wholly dark, but may show light reflections on a few scales, on some specimens, depending on the angle of the light. The ungues on the fore- and mid-legs are large, unequal and simple. On the hind legs the tibiæ are dark save for a brilliant white spot at the base, and so are the first tarsals but the white spot is much smaller, the second and third joints are dark, and the fourth and fifth are pure white (in some specimens a dirty white) with occasionally a tiny dark spot at the extreme tip. There is a line of porrect scales on the distal half of the tibia, extending on the first tarsal (H. D. & K.'s "scraper"?).

Wings are long and slender (285-50), the membrane clear and the veins clothed with "Tæniorhynchus" like scales, those on the costa, subcosta, and the fork of the second long vein almost obvate, and having a brilliant blue iridescence; the cells are very long and slender (80-5). First submarginal nearly one-third the length of the wing. The stems are proportionally short, not over one-fifth the length of the first submarginal and that of the second posterior slightly longer; the cross veins are nearly in a line, the mid and posterior about equal in length. The halteres have the base very light, but most of the stem and the knob are dark.

Length: 6-6 mm.

Taken: December 1, Larvæ found in a coconut shell.

Habitat: Chagras Camp, Las Cascades, Canal Zone.

The species lies near *nivipes* and of course may be *digitatus* but is believed to be new, in spite of the fact that what seems to be the same female is described by H. D. & K. as *digitatus* and the peculiarities of the male mid-legs are not referred to.

Colonel W. H. Wilson, M. C., who sent me the specimens says they are markedly canabalistic, the larvæ eating not only the young of other species, but even the smaller members of their own species.

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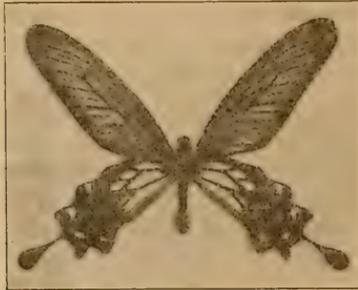
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SYNOPTIC KEYS TO THE LYGÆIDÆ (HEMIPTERA) OF THE UNITED STATES.

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PART II. RHYPAROCHROMINÆ.

As indicated by Stål the most important character for differentiating this subfamily is the peculiarity of the incisure between the third and fourth ventral abdominal segments which laterally curves forward and does not reach the lateral margin of the abdomen. *Plinthisus* is about the only exception to this among United States genera. The presence of two setæ, set close to each eye, is also characteristic of the group. Stål (Öfv. Vet.-Akad. Förh 1872) first divided this subfamily into six divisions: Myodocharia, Rhyparochromaria, Beosaria, Gonianotaria, Lethæaria, and Drymaria. Two years later (Stål, Enum. Hemipt. Pt. 4, 1874), in constructing a synopsis to include extra-European genera, Stål added Cleradaria, combined Drymaria with Lethæaria and omitted all mention of the Gonianotaria. Accepting Stål's arrangement this subfamily is therefore composed of six main divisions which Mr. Van Duzee has recently termed tribes to bring them more into accord with modern system of nomenclature. In separating certain of his divisions Stål relied principally upon two characters—the position of the two opaque spots of the fourth ventral abdominal segment in reference to each other and the character of the lateral margin of the pronotum. Owing to the difficulty of interpreting these characters exactly in every case or owing to their variability the accuracy of Stål's divisional arrangement has been called in question by several Hemipterists. Distant (Biol. Cent. Amer., p. 212, 1882) recognizes Myodocharia and combines all of the other divisions under Rhyparochromaria, stating that "I have here failed to interpret his [Stål's] meaning sufficiently to prevent confusion." Bergroth (Ann. Soc. Entomol.

Belg., p. 153, 1913) has more recently advocated the union of the Lethæini and Rhyparochromini in the following words: "After examination of many specimens of *Microcoris* and other exotic Myodochinæ I believe, however, that the number and position of the glandular spots have been overrated as a systematic character by Stål. One or other of these spots is sometimes lacking, at least on one side of the body. I therefore unite the Lethæaria with the Rhyparochromaria. . . ."

After a careful study of all the United States genera, in preparation for my revision of this subfamily, I am convinced that, so far at least as our fauna is concerned, Stål's divisional diagnosis will apply in separating the genera off into well defined groups. However my knowledge of palæarctic and exotic genera of Rhyparochrominæ is too limited, at the present time, to permit me to determine how well this scheme applies beyond our limits. Hence without more evidence than we have at the present time I am reluctant to abandon Stål's scheme of divisions.

As it is obviously impossible, in a paper of this character, to enter into explanations, I have found it necessary to publish elsewhere such modifications of or additions to the present scheme, which I have here proposed. It will be noted that although I have adopted Stål's divisions I have modified the wording somewhat, in order to bring out the relative importance or the greater significance of certain characters. Attention must also be called to the fact that the species mentioned in connection with certain genera is not necessarily the type unless so indicated.

KEY TO THE TRIBES OF SUBFAMILY RHYPAROCHROMINÆ.

- A. The two basal segments of the rostrum together not at all or scarcely longer than the head, third segment longest of all. Posterior glandular opaque spot of the fourth ventral segment remote from the apical margin. Ocelli very widely separated. *Cleradini* Stål.
- AA. The two basal segments of the rostrum much longer than the head, the first segment as long or nearly as long as the head. Ocelli not so widely separated.
- B. With the two glandular opaque spots laterally on the fourth ventral segment, widely separated, the posterior one placed closer to the posterior margin than to the anterior spot.

- C. Pronotum with the lateral margins of the anterior lobe obtuse, terete, neither calloused, carinate nor expanded nor longitudinally impressed within the lateral margin of the propleura; most commonly strongly constricted transversely to form two distinct lobes and most commonly provided with a constricted ring-like collar. [If collar is absent then is the head not at all or very lightly exerted (see Div. CC.). Body commonly less depressed, more narrowelongate.].....*Myodochini* Stål.
- CC. Pronotum with the lateral margins of the anterior lobe not obtuse or terete but either calloused or carinate or expanded or the lateral emargination filled in by a foliaceous expansion or furnished within the lateral margin with a series of punctures or the propleura with a linear impression within the lateral margin. Pronotum rarely strongly constricted transversely, if so then is the lateral margin carinate or expanded or the lateral emargination filled in by a foliaceous expansion, or the propleura impressed within the lateral margin; rarely furnished with a constricted ring-like collar unless the head is strongly exerted or at most only provided with a depressed series of punctures within the anterior margin. Body most commonly broad with the head most commonly, almost or quite immersed to the eyes.
- D. Lateral margins of the pronotum not at all or less entirely laminate-expanded, most commonly either carinate or longitudinally impressed within the lateral margin of the propleura. Pronotum most commonly entirely black, ferruginous or castaneous, with the posterior lobe rarely paler, punctuate with black. [Head rarely strongly exerted, if so, then is the constricted collar present anteriorly on the pronotum (*Ozophora*). Hind tibia most commonly without rigid bristles only, most frequently pilose.].....*Rhyparochromini* Stål.
- DD. Entire lateral margin of the pronotum and costa [more or less] laminate-expanded (in U. S. genera) and most commonly in part pale; this margin rarely only keeled (in certain exotic genera), in which case the first segment of the antenna is extended far beyond the apex of the head

and the genital segment of the male is tuberculate; pronotum (including margin) most rarely entirely black, posterior lobe most commonly pale or variegated with pale. Posterior tibia furnished with long rigid subspini-form setæ [bristles].

- E. Antennæ nude or with shorter pubescence, first segment sometimes furnished with a few shorter setæ. Lateral [more narrowly] expanded margin of the pronotum not at all or rarely sparingly punctate; anterior disk of the pronotum most commonly smooth or sparingly punctate, rarely densely punctate. *Beosini* Stål.
- EE. Three basal segments of the antennæ provided with rigid setose bristles. Lateral [more widely] expanded margin of the pronotum and corium commonly [profusely] punctate. Clavus irregularly punctate. Dorsal parts commonly pale [and profusely punctate]
Gonianotini Stål.
- BB. The posterior glandular, opaque spot of the fourth ventral segment of the abdomen placed closer to anterior spot, most remote from the posterior margin of the segment, sometimes furnished with a third, posteriorly placed, spot. [With lateral margin of pronotum most commonly expanded, this frequently foliaceous between the lobes]. . . . *Lethæini* Stål.

TRIBE MYODOCHINI Stål.

- A. Head very much exerted, drawn out into a long cylindrical neck at base; longer than pronotum. Two lobes of pronotum subequal. Body narrow elongate. Hind tibia furnished with long, setose hairs. Basal segment of hind tarsus about three times as long as second and third together. Macropterous forms only. *Myodochus* Oliv.
- AA. Head either exerted or not, but never drawn out into a long cylindrical neck. Collar more rarely absent (see Div. CC.).
- B. Pronotum commonly constricted at middle or a little behind middle; anterior lobe in all macropterous forms and in most brachypterous forms never or scarcely ever more than twice as long as posterior lobe, if more than doubly longer then the head is not exerted (as in brachypterous forms of some *Ptochiomera*).

- C. Head more or less distinctly exserted. Pronotum with a constricted ring-like collar. Body more or less elongate.
- D. Head strongly exserted, forming a short neck at base; the postocular space about four times as long as the space between the antenna and eye. The eyes placed about midway on the head. Hind tibia provided with fine rigid bristles. Basal segment of posterior tarsus about as long as second and third together. Macropterous and brachypterous forms.....*Heræus* Stål.
- DD. Head much less exserted, commonly strongly contracted back of eyes; postocular space commonly subequal to or sometimes shorter than space between base of antenna and eye.
- E. Anterior lobe of pronotum, especially in brachypterous forms, globose, almost the diameter and about twice the length of posterior lobe. Postocular space subequal to space between antenna and eye. Scutellum much longer than wide. Head and pronotum shining. Hind tibia with rigid bristles. Posterior tarsus with first segment nearly three times as long as second and third together. Macropterous and brachypterous forms.
Sphærobius Uhl.
- EE. Anterior lobe of pronotum not so evidently globose and narrower than posterior lobe. Head and thorax seldom shining. Basal segment of posterior tarsus most commonly not more than twice as long as second and third together, if three times as long as second and third then the posterior tibia is provided with long rigid bristles.
- F. Preocular space to base of antenna about three times as long as postocular space; head not strongly contracted back of eyes; apex of tylus not extended to middle of basal segment of antenna; this segment in-crassate and elongate, a little longer than basal segment of rostrum; second segment very elongate, over twice as long as the third or fourth, longer than third and fourth together. Pronotum with anterior lobe twice as long as posterior. Collar set off by a depressed series of punctures. The anterior femora armed with two rows of spines, the outer series confined to the subapex.

The posterior tibia provided with a few scattered setose hairs similar to those of antennæ. Hind tarsus with basal segment about twice as long as second and third together. Only macropterous females known to me (Type—*Pseudopamera forreri* Dist.).

Cænopamera Barb.

- FF. Preocular space to base of antenna not more than twice the length of the postocular space, most commonly subequal to it. Head strongly contracted back of eyes; apex extending to or beyond the middle of basal segment of antennæ which is very evidently shorter than first segment of rostrum, second segment much shorter than third and fourth together. Pronotum with the collar most commonly set off by an impressed line.
- G. The two lobes of the pronotum commonly separated by a deep, clean cut, transverse constriction. First segment of rostrum commonly not reaching base of head. Postocular space of head commonly subequal to or sometimes a little shorter than space between antenna and eye. Hind tibia most commonly furnished with short bristles.
- H. Second and third ventral abdominal segments furnished with two very finely strigose, opaque, lunate vittæ. *Ligyrocoris* Stål.
- HH. Second and third ventral abdominal segments unprovided with lunate, strigose vittæ. (To include subgenus *Paromius longulus* Dall.) *Orthæa* Dall.
- GG. The two lobes of the pronotum commonly separated by a shallow obtuse constriction. First segment of rostrum commonly reaching base of head.
- I. Posterior tarsus with basal segment fully three times as long as second and third together. Hind tibia provided with long rigid bristles only. Antennæ nearly nude. Form of body narrow elongate, with longer legs. Scutellum carinate throughout. (Type—*Perigenes costalis* Van Duz.)

Zeridoneus Barb.

- II. Posterior tarsus with basal segment not more than twice as long as second and third together. Hind tibia with long setose hairs similar to those of antennæ and provided with a few rigid bristles apically. Form of body more broadly oval with shorter legs.....*Perigenes* Dist.
- CC. Head not at all or scarcely exerted, commonly immersed to the eyes. Pronotum without a constricted ring-like collar, at most with anterior margin depressed or furnished with a series of punctures. Clavus with three rows of punctures.
- J. Scutellum much longer than wide and posteriorly distinctly carinate. Pronotum strongly constricted to form two lobes, both of which are punctate; the disk of the anterior lobe sometimes more sparsely so. Posterior tarsus with the basal segment subequal to the second and third together. Species rarely pilose.
- K. First segment of antenna longer, exceeding apex of tylus by one-half its length. Within anterior margin of pronotum depressed, punctate. Basal disk of scutellum depressed before a premedian transverse or crescentic ridge, posteriorly to which, carinate. Fore femora armed with several teeth. Males sometimes with fore tibia armed with a median tooth. In brachypterous forms the membrane may be almost or entirely wanting, the clavus flat, not deflected to the corium and the anterior lobe of the pronotum swollen and more than twice the length of the posterior. Species not at all or only slightly shining. (To include *Carpilis ferruginea* Stål. and *Sisamnes contractus* Dist.).....*Ptochiomera* Say.
- KK. First segment of antennæ short scarcely exceeding the tylus. Anterior margin of pronotum not depressed. Basal disk of scutellum depressed followed by a longitudinal carina. Incrassate fore femora armed with two or three preapical teeth one of which is frequently enlarged. In

brachypterous forms the membrane is only shortened, the clavus always deflected to the corium. Species very shining. (Type—*Rhyparochromus plenus* Dist.).....*Kolenetrus* Barb.

JJ. Scutellum subequilateral, posteriorly not distinctly carinate. Pronotum either not pilose and finely punctate in front, in which case it is not strongly constricted to form two lobes or the pronotum very pilose and obsoletely punctate in front and then strongly and obtusely constricted to form two lobes. Posterior tarsus with basal segment decidedly longer than second and third together. Species not at all or faintly shining.

L. Antennæ and dorsal parts very pilose. Pronotum longer than wide, strongly contracted back of the middle to form two lobes; the anterior lobe obsoletely and sparsely punctate. First segment of antenna longer exceeding apex of tylus by nearly one-half its length. Costal margin of corium gently convexed. Forefemora provided with two or three minute preapical teeth and long setæ throughout. Clavus distinct and deflected to the corium. Membrane reaching the end of abdomen. Only macrop-terous forms known to me. (Type—*Valonetus pilosus* Barb.).....*Valonetus* Barb.

LL. Antennæ and dorsal parts not at all or very sparsely pilose. Pronotum lightly transverse or quadrate, finely and distinctly punctate, anterior *disk* sometimes impunctate, not strongly constricted to form two lobes. First segment of antenna short barely exceeding tylus. Fore femora armed with two or three minute teeth in the middle, tipped with long setæ. In brachypterous forms clavus connate with the corium, the membrane wanting and pronotum more quadrate. (*Esuris tergina* Stål and *castanea* Barb.).....*Esuris* Stål.

BB. Anterior lobe of pronotum three or four times as long as posterior lobe, with the transverse constriction between the lobes commonly shallow and obtuse or ill-defined. Head distinctly exerted; postocular space subequal to space between antenna and eye; most commonly not abruptly contracted back of eyes. Fore tibia of males provided with a submedian tooth. Antenna elongate; apex of head not attaining middle of basal segment; this segment subequal to basal segment of rostrum. Basal segment of posterior tarsus two or three times as long as second and third segments together. Membrane not entirely wanting in brachypterous forms.

M. Anterior lobe of pronotum impunctate, demarcated from the posterior lobe by a transverse, impressed line; provided with a distinct ring-like collar. Basal segment of antenna with a few setose bristles. Ocelli absent. Fore tibial tooth of male at middle or posterior to the middle. Hind tibia provided inwardly and outwardly with rigid bristles. Basal segment of hind tarsus three times as long as second and third together. Larger species.

Cnemodus H. S.

MM. Anterior lobe of pronotum sparsely punctate, the two lobes separated by an obtuse sinus, not indicated by an impressed line; anterior margin depressed, punctate. Basal segment of antenna without setose bristles. Ocelli present. Fore tibial tooth of male anterior to middle. Hind tibia with a few setose bristles inwardly. Basal segment of posterior tarsus about twice the length of second and third together. Smaller species. (Type—*P. canadensis* Prov.) *Pseudocnemodus* Barb.

TRIBE RHYPAROCHROMINI.

A. Anterior margin of the pronotum provided with a distinct ring-like collar, behind which is a depressed series of punctures; lateral margins strongly keeled or lightly expanded

and reflexed; distinctly separated into two lobes by an obtuse constriction just before middle. Head not transverse, exerted, commonly contracted back of eyes, space between antenna and eye most commonly subequal to postocular space. Basal segment of antenna stout and long, apex of tylus not reaching middle of segment. Basal segment of rostrum reaching base of head, longer than basal segment of antenna. Clavus irregularly punctate. Anterior femora elongate, not strongly incrassate, armed beneath with three or four equidistant spines. Posterior tibia with short rigid bristles. Mostly macropterous forms. (To include genus *Balboa* Dist.).....*Ozophora* Uhl.

- AA. Anterior margin of pronotum without a ring-like collar, at most faintly impressed or provided with a series of punctures within. Head transverse, not at all or very lightly exerted. Lateral margins of pronotum sometimes carinate but most commonly merely longitudinally impressed within the lateral margin of the propleura. Hind tibia without rigid bristles.
- B. Pronotum with the lateral margins strongly carinate and reflexed; lightly transversely impressed just behind middle, both lobes punctate; posterior margin straight. Head short, wide, slightly exerted, suddenly and strongly contracted back of eyes. First segment of rostrum shorter than head, subequal to first segment of antenna. Scutellum subequilateral, equal to length of commissure. Swollen anterior femora provided with numerous small teeth. Anterior tibia strongly curved. Posterior tibia nude. Only macropterous forms known to me.....*Tempyra* Stål.
- BB. Lateral margins of pronotum very lightly keeled and not reflexed or acute or only linearly impressed within the lateral margins of the propleura. Head not at all or most lightly exerted.
- C. Pronotum distinctly transverse with disk of anterior lobe black; posterior lobe testaceous punctate with fuscous; lateral margin lightly carinate. Scutellum much longer than wide, a little longer than pronotum, posteriorly bivittate with pale. Dorsal parts dull, not pilose. Fore femora incrassate and armed with three or four stronger

and several smaller teeth distributed along almost entire length. Clavus with three rows of punctures, the middle series abbreviated. Macropterous forms only.

Peritrechus Fieb.

CC. Pronotum with both lobes concolorous or nearly so, most commonly ferrugineous or castaneous, rarely black, most commonly shining or somewhat so. Scutellum not bivariate with pale.

D. Third ventral suture of the abdomen straight and reaching the lateral margin. Head across eyes distinctly narrower than anterior margin of pronotum. Pronotum with lateral margins more or less strongly keeled, with impunctate anterior lobe as wide or wider than the much shorter posterior lobe. Scutellum subtransverse. Clavus broad, not deflected to the corium, sometimes connate with the corium. Membrane usually abbreviated or wanting. Only brachypterous forms known to me.

Plinthisus Latr.

DD. Third ventral suture of the abdomen curved anteriorly and not reaching the lateral margin. Head across eyes as wide or most commonly wider than the anterior margin of the pronotum, most frequently as wide as across rounded submargin.

E. Pronotum with both lobes very distinctly and closely punctate and at the same time with the lateral margins evidently carinate. Scutellum longer than wide. Fore femora unarmed.

F. Lateral margins of pronotum more strongly carinate. Eyes more projecting. Pronotum and hemielytra not pilose. Clavus with three rows of punctures.

Acompus Fieb.

FF. Lateral margins of pronotum narrowly carinate. Eyes less projecting. Pronotum and hemielytra pilose. Clavus with four series of punctures.

Stygnocoris D. and S.

EE. Pronotum with the entire anterior lobe or the disk only impunctate; lateral edge either very finely carinate or the propleura linearly and longitudinally impressed within the lateral margin. Scutellum equilateral.

Fore femora lightly incrassate, armed or unarmed.
Very small species.

- G. Scarcely shining. Form short and broad. Pronotum not strongly, transversely constricted to form two lobes; anterior disk impunctate; lateral edge very narrowly carinate. Basal segment of rostrum (in U. S. species) shorter than first segment of antenna.

Antillocoris Kirk.

- GG. Somewhat shining. Pronotum rather strongly transversely constricted; the anterior lobe impunctate; the lateral edge linearly impressed within the lateral margin of the propleura. Basal segment of rostrum subequal to the basal segment of antenna. Inner apical margin of corium sinuate. ("*Salacia*" *delineata* Dist.).....*Cligenes* Dist.

TRIBE BEOSINI.

- A. Lateral margin of the pronotum linearly and evenly expanded, not reflexed; expansion not widened between the two lobes which are not distinctly differentiated by a transverse constriction; pronotum transverse without a depressed collar. Head about as wide across the eyes as the diameter of anterior submargin of pronotum. Antenniferous tubercles, seen from the side, strongly oblique, almost perpendicular. Scutellum not carinate. Antennæ not incrassate; basal segment short, apical third extended beyond apex of head.
- B. Dorsal parts not entirely black, either the lateral explanate margin of the pronotum, or commonly the posterior lobe of the pronotum pale, punctate with black, or the posterior margin of the pronotum conspicuously or the corium more or less pale. Species commonly dull not shining. Anterior margin of the pronotum nearly straight.
- C. Explanate lateral margin of pronotum most commonly pale, neither punctate nor furnished with setæ. Scutellum rarely bivittate with pale. Antennæ sparsely pilose or almost nude. First segment of posterior tarsus distinctly longer but not twice as long as second and third segments together.

- D. The posterior lobe of the pronotum and corium pale, distinctly and rather coarsely punctate with black; the lateral explanate margins pale; pronotum narrowed in front, the lateral margins gently rounded anteriorly. Antennæ pilose. Anterior tibia, especially in the male, curved at base. *Trapezonotus* Fieb.
- DD. The posterior lobe of the pronotum concolorous with the anterior lobe, not at all or obsoletely and finely punctate, black or at most with the posterior margin only pale. Corium for the most part pale, more or less infuscated. Lateral explanate margins of the pronotum most commonly pale, rarely black; pronotum less narrowed in front, the lateral margins more nearly parallel. Antennæ nearly nude. Anterior tibia nearly straight. (Type—*Trapezonotus rufipes* Stål and *Rhyparochromus sodalicus* Uhl. etc.) *Malezonotus* Barb.
- CC. Explanate pale lateral margins of the pronotum, provided with a few punctures set with long setæ. Scutellum most commonly bivittate with pale. Antennæ provided with numerous setose hairs. First segment of posterior tarsus commonly subequal to the second and third together. *Sphragisticus* Stål.
- BB. Entirely black, or the legs rarely pale. Subshining. Pronotum very transverse, not depressed posteriorly; anterior margin lightly concave. Third segment of the rostrum shorter than the second. Anterior femora armed with one large preapical spine, preceded and followed by one or two smaller spines. Clavus with four series of punctures, the two middle series abbreviated and confused. Posterior tarsus with basal segment subequal to second and third together. Macropterous forms only known to me. (*Aphanus umbrosus* Dist.) *Aphanus* Lap.
- AA. Lateral margins of the pronotum more lamellarly expanded and plainly reflexed, the expansion widened between the two lobes which are very obviously separated by a transverse constriction; posterior lobe depressed and profusely punctate; anterior margin straight, within, provided with a depressed series of punctures. Head scarcely transverse; antenniferous tubercles, seen from the side, obliquely declivous. Anten-

næ incrassate; basal segment longer. Second segment of rostrum longer than third. Scutellum posteriorly, obtusely carinate. Posterior tarsus with basal segment almost twice as long as second and third together. Macropterous and brachypterous forms.....*Uhleriola* Horv.

TRIBE GONIANOTINI Stål.

Lateral margins of pronotum widely laminate, wider than the diameter of the eye, not reflexed, pale and rather profusely punctate with fuscous. Pronotum very transverse, anterior margin gently arcuated, the anterior rounded angles projecting a little beyond eyes. Costal margin of the corium widely laminate, lightly reflexed and punctate with fuscous. Scutellum almost as long as the pronotum. Clavus irregularly punctate. Head transverse. Antennæ set close to the eyes. Space between antennæ and eyes about one-half the length of the eye. Posterior tibia furnished with setose bristles. Basal segment of posterior tarsus fully twice as long as second and third together. Only macropterous forms.

Emblethis Fieb.

TRIBE LETHÆINI Stål.

A. Pronotum with both lobes distinctly and closely punctate, the posterior lobe more coarsely so; lateral margins lightly expanded, more widely so between the lobes, slightly sinuate and commonly in part pale; anterior margin without a semblance of a collar, but area behind this somewhat depressed and profusely punctate. Costal margins of corium anteriorly widely expanded, and broadly reflexed. Eyes not in contact with anterior margin of pronotum. Basal segment of antenna shorter than head but well extended beyond its apex. Anterior tibia of males either strongly curved or bent and strongly expanded apically within and armed with one or two stout preapical teeth. Hind tibia without rigid bristles. Fourth abdominal ventral segment having the two anterior glandular, opaque spots without a third subapical spot.

B. Body not strongly depressed or flattened. Lateral margins of pronotum not strongly converging anteriorly, anterior angles strongly and rather abruptly rounded. Width of head across eyes much narrower than across rounded sub-

margin of pronotum. Lamellar lateral expansion very distinct on both lobes. Antennæ rather strongly pilose. Mesosternum not longitudinally sulcate. Basal segment of posterior tarsus distinctly longer than second and third segments together. Third ventral suture of abdomen strongly curved anteriorly and not reaching lateral margin.

Drymus Fieb.

- BB. Body much flattened. Lateral margins of pronotum strongly converging anteriorly, anterior angles gently rounded. Width of head across eyes subequal to width across rounded submargin of pronotum. Lamellar lateral expansion less obvious on the anterior lobe. Antennæ not pilose. Mesosternum strongly sulcate. Basal segment of posterior tarsus subequal to second and third segments together. Third ventral suture of abdomen almost straight and reaching the lateral margin. *Gastrodes* Westw.
- AA. Pronotum with the anterior lobe impunctate or obscurely punctate. Anterior tibia of males not so strongly curved or bent or abruptly expanded at apex. Fourth ventral abdominal segment with or without the third subapical glandular opaque spot.
- C. Dorsal parts dull. Anterior margin of pronotum depressed and commonly pale, limited behind by a row of punctures; lateral lamellar expansion noticeably wider between the two lobes, for the most part commonly pale. Fourth ventral abdominal segment without the third subapical spot. Hind tibia without long rigid bristles; at most with a few short setose bristles or pilose.
- D. Pronotum much longer than wide; anterior lobe subquadrate and disk obsoletely punctate. Antennæ very long, slender and nude; first segment as long or a little longer than the head, longer than first segment of rstrum, apex of head not reaching middle point; third segment longer than fourth. Head submerged to the eyes; head across eyes as wide as anterior margin of pronotum. Lateral margins of pronotum and corium widely lamellarly expanded and broadly reflexed. Corium dorsally flattened not transversely convex. Scutellum longer than wide. Clavus distinctly widened posteriorly, rather closely and

- irregularly punctate. Commissure nearly as long as scutellum. Bucculæ lightly elevated and extended posteriorly to meet on the middle line of eyes. Much swollen anterior femur armed with a single large subapical tooth between which and the apex are several small teeth. Posterior tibia furnished with a few fine short bristles, not at all pilose. Posterior tarsus with the basal segment twice as long as the second and third segments together. (Type—*T. genuinus* Barb.) *Togodclentus* Barb.
- DD. Anterior lobe of pronotum transverse, impunctate and most commonly black. Antennæ shorter; first segment shorter than head, subequal to or shorter than the first segment of rostrum, well extended beyond apex of head. Head most commonly lightly exserted. Lateral margins of pronotum and corium more narrowly expanded. Commissure distinctly shorter than scutellum. Clavus punctate in more regular series. Basal segment of posterior tarsus never twice as long as second and third segments together.
- E. Species larger, most commonly 6 to 7 mm. long. First segment of antenna longer; apex of tylus not reaching middle of first segment. Head longer than width back of eyes. Lateral margin of pronotum commonly more or less pilose. Hind tibia with short fine bristles or pilose. *Eremocoris* Fieb.
- EE. Species smaller, commonly 3 to 4 mm. long. First segment of antenna shorter; apex of tylus reaching at least to the middle of this segment. Head shorter, length subequal to width back of eyes. Lateral margins of pronotum without long soft hairs. Hind tibia not pilose or furnished with short bristles. *Scolopostethus* Fieb.
- CC. Dorsal parts shining or somewhat shining. Lateral edge of the pronotum not obviously widened between the two lobes and most commonly not pale; each anterior angle of the pronotum provided with a long seta. Fourth ventral abdominal segment commonly furnished with an additional third subapical opaque spot. Scutellum longer than wide. Hind tibia furnished with rigid bristles.

- F. The lateral edge of the pronotum concolorous, not definitely demarked or bordered by an impressed line, much compressed or acute and beneath strongly impressed within the lateral margin of the propleura; the lateral margins nearly straight and converging anteriorly; anterior and posterior margins straight. Width of head across eyes a little narrower than across anterior submargin of the pronotum. Basal segment of rostrum nearly equal to basal segment of antenna. Dorsal parts pilose.
- G. Fore femora provided with a few tubercles and numerous long setæ. Antennæ somewhat incrassate. Basal segment of posterior tarsus nearly twice as long as second and third together. Hind tibia with strong bristles. Surface not strongly shining.
- Cistalia* Stål.
- GG. Fore femoræ provided with several minute preapical teeth with or without setæ. Antennæ not incrassate and pilose. Basal segment of posterior tarsus a little longer than second and third segments together, but never twice as long. Hind tibia with short fine bristles.
- H. Pronotum very transverse, nearly twice as wide as long, posterior lobe sparsely punctate. Clavus deflected to corium and provided with three regular rows of punctures. Corium finely punctate. Antennæ set close to the eyes, antenniferous tubercles less than one-half the length of the eyes. Membrane reaching apex of abdomen. Only macropterous forms known to me. (Type—*Petissius diversus* Dist.) *Valtissius* Barb.
- HH. Pronotum more lightly transverse, almost impunctate except behind anterior margin. Clavus almost flat, with four series of punctures. Corium sparsely punctate. Antennæ further removed from the eyes, antenniferous tubercles only a little shorter than the eyes. Membrane abbreviated. Dorsal parts very shining. Only brachypterous forms known to me. (Genus *Rhaptus* Stål?) *Xestocoris* Van D.

FF. Narrow lateral expansion of the pronotum sharply demarked and most commonly pale; not widened between the two lobes which are poorly differentiated from each other, merely posteriorly lightly depressed and sparsely punctate; pronotum transverse, the two sides subparallel. Head submerged to eyes; width of head across eyes much narrower than across anterior submargin of pronotum where the angles are rather abruptly rounded. Antennæ more slender. Posterior tibia with long rigid bristles. Basal segment of posterior tarsus a little longer than second and third together. Fore femora with several small subapical tubercles. Brachypterous and macropterous forms. (To include *Trapezus* Dist.) *Cryphula* Stål.

ANOTHER *TOXOPTERA* FEEDING ON SEDGE (HOMOPTERA; APHIDIDÆ).

BY A. C. BAKER,
Washington, D. C.

During the summer of 1916, there appeared on the sedges in a little marsh at East Falls Church, some dark colored apterous aphids. These were kept under observation and some were transferred to rearing cages. From these, sexes and eggs were obtained in the fall. None of the eggs, however, hatched the following spring. Visits to the marsh were made too late to secure a supply of stem mothers. Apterous forms were secured in the second generation and from these alate forms were secured. In the key given by Davis¹ this species would fall under *aurantii* from its color and would be excluded from *scirpi* by the nature of the hairs present in that species. It is therefore recorded under a new name.

Toxoptera nigra sp. nov.

Alate vivipara.

The alate forms began to appear in the rearing cages in the third generation. It is quite possible, however, that lines from a sufficient number of stem mothers would show alate forms produced in

¹ Tech. Ser. No. 25, Pt. I, p. 8, U. S. D. A. Bur. Ent.

the second generation also. These forms are produced throughout the summer in the different generations, but toward fall they appear in very small numbers and when the sexes are appearing very few alate forms can be found. The alate forms either reproduce upon the plant on which they developed or fly to other plants of the same species.

Fourth instar (pupa). General color brownish black, the thorax somewhat pinkish or whitish brown, otherwise colored as in the apterous form. Antennæ with the following measurements: Segment III, 0.208 mm.; IV, 0.16 mm.; V, 0.16 mm.; VI (0.08+0.4 mm.); cornicles 0.192 mm.; antennal tubercles quite acute in front and armed with short stout spines; vertex similarly armed.

When cleared of the body fluids the abdomen and most of the thorax appear to be almost transparent. The antennæ, head, legs, wingpads and cauda are dusky and the cornicles dark brown.

Fifth instar (adult). General color deep brownish or purplish black. Antennæ somewhat lighter than the general body color. Abdomen and cauda sometimes of a dark greenish color. Cornicles black, sub-cylindric, slightly constricted near the tip and distinctly flanged. Legs with the base of the femora and most of the tibiæ yellowish or whitish. Measurements and sensoria as given in Table I.

TABLE I. MEASUREMENTS OF ANTENNÆ AND CORNICLES OF THE ALATE VIVIPARA.

Segment III.	Sensoria of Segment III.	Segment IV.	Sensoria of Segment IV.	Segment V.	Sensoria of Segment V.	Segment VI.	Cornicle.
0.304	13	0.192	5	0.176	2	0.08 +0.4	0.24
0.304	12	0.192	6	0.176	2	0.09 +0.432	0.24
0.288	13	0.192	5	0.192	2	0.096+0.432	0.24
0.304	10	0.208	7	0.208	2	0.08 +0.448	0.24
0.304	9	0.192	6	0.192	2	0.096+0.464	0.24
0.304	11	0.192	7	0.176	1	0.08 +0.432	0.24
0.32	10	0.224	6	0.176	2	0.08 +0.448	0.24
0.288	13	0.192	6	0.176	3	0.096+0.432	0.24
0.288	13	0.208	7	0.176	3	0.096+0.432	0.224
0.304	9	0.192	4	0.192	3	0.08 +0.432	0.24

When cleared of the body fluids the chitin is found to be marked as follows: The head, thorax, antennæ, cornicles and legs are marked as indicated above. The abdomen becomes clearly transparent with the exception of a row of rather large black patches on each lateral margin, each patch surrounding a spiracle. The cauda, and genital plates are likewise dusky. In some specimens one or two narrow dusky bands are present caudad of the cornicles.

Apterous Vivipara.

The apterous viviparous forms occur upon the sedges during most of the year. They produce large numbers of young, some of which become alate and others continue the apterous lines throughout the summer.

Fifth instar (adult). General color dark greenish black, some specimens dull while others are glossy. Antennæ, eyes and cornicles black. Distal extremities of the femora and tibiæ and the tarsi black, remainder of the legs yellowish. When mounted in balsam the abdomen appears greenish in color, and when cleared the abdomen and thorax are transparent with the exception of the cauda, anal and genital plates and small dots along the sides of the abdomen. Measurements of the appendages are given in Table II.

TABLE II. MEASUREMENTS OF ANTENNÆ AND CORNICLES OF APTEROUS VIVIPARA.

Segment III.	Segment IV.	Segment V.	Segment VI.	Cornicle.
0.288 mm.	0.192	0.16	(0.064+0.384)	0.288
0.272	0.192	0.176	(0.084+0.4)	0.288
0.288	0.176	0.176	(0.08 +0.416)	0.272
0.32	0.176	0.176	(0.096+0.432)	0.288
0.32	0.176	0.176	(0.096+0.432)	0.288
0.272	0.176	0.16	(0.08 +0.416)	0.272
0.256	0.192	0.176	(0.08 +0.432)	0.272
0.304	0.192	0.176	(0.096+0.368)	0.272
0.256	0.192	0.176	(0.096+0.368)	0.288
0.272	0.176	0.16	(0.08 +0.384)	0.272

Male.

The males of this species appeared in the breeding cages during the early part of November and remained in considerable numbers until cold weather put a check to their activities. In connection with these males a reference to those of *muhlenbergia* Davis will be of interest. Davis (l.c.) described the males of that species as apterous and gave an excellent figure. Baker and Turner¹ in referring to the male stated their belief that the individuals were intermediates. The structure of the thorax and the ocelli are well shown in the figure. Males of the present species indicate that this view is correct. Several specimens, evidently indicating the normal condition of the male, resemble the condition met with in the males of *muhlenbergia*. They possess more or less of the thoracic structure of the alate form and also the head, while the wings are entirely absent. Other specimens, however, are more distinctly intermediate in nature, having small pad-like structures representing the wings. One specimen was obtained in which fully formed wings were present. The entire life cycle as observed at Falls Church is spent upon the sedge and the eggs are laid upon these plants in the fall. The presence of alate forms in the viviparous generations and more particularly this peculiar intermediate condition of the males would seem to indicate that this habit of remaining upon the one host has not been of very long duration in this species. No truly apterous males have been observed and it appears from the intermediate nature of the wingless males that the species has not yet developed to the condition in which truly apterous males may be found. For the sake of convenience the wingless males will be called apterous though they still retain the muscles of flight and other related alar structures.

Apterous male: General color deep brownish black, the abdomen somewhat paler than the rest of the body, base of the femora and most of the tibiæ yellowish. Cornicles, anal and genital plates black.

Antennæ with the following measurements: Segment III, 0.384 mm.; IV, 0.192 mm.; V, 0.192 mm.; VI (0.08+0.4 mm.); Segment III, with 12 or 13 small circular sensoria in an uneven row, Segment IV with about the same number and Segment V with 9

¹Proc. Ent. Soc. Washington, vol. 18, p. 10-14.

or 10. Cornicles 0.176 mm. long, tapering near the base, then very slightly enlarged, then again slightly tapering; distal extremity with a distinct flange and the entire cornicle distinctly imbricated. Hind tibiæ 0.656 mm. long. Ocelli present, thoracic structure suggesting that of an alate form. Length from vertex to tip of cauda 0.944 mm.

Intermediate male: General color similar to that of the apterous form, the abdomen, however, appears to be slightly lighter. Antennæ with the following measurements: Segment III, 0.304 mm.; IV, 0.192 mm.; V, 0.192 mm.; VI (0.08+0.416). Sensoria present as follows: Segment III, with about 22 circular sensoria not arranged in a row, IV, with about 20 sensoria, V, with about 16. Cornicle 0.192 mm. long, similar in shape to the cornicle of the apterous form. Wings represented by leaf-like structures about 0.368 mm. long and about 0.192 mm. wide. These structures sometimes show one or two veins. Head and thorax like that of the alate form. Hind tibiæ 0.672 mm. Length from vertex to tip of cauda 1.04 mm.

Alate male: Color similar to that of the forms previously described. Wings hyaline, veins and stigma dark. Antennæ with the following measurements: Segment III, 0.32 mm.; IV, 0.256 mm.; V, 0.256 mm.; VI (0.096 mm.+0.448 mm). Sensoria as follows: Segment III, with about 17 circular ones more or less in a row; IV, with about 17; V, with about 17. Forewing with the stigma near the distal extremity of the wing, so that it is quite curved on its costal margin, media once branched, cubitus distinct, anal absent, length 1.152 mm. Hind wing about 0.656 mm. long and with one oblique vein. Cornicles 0.16 mm. long, similar to those of the other forms already described. Hind tibia 0.672 mm.; length from vertex to tip of cauda 0.96 mm.

Found on the sedge in company with the oviparous females, often very close to the ground.

Ovipara.

The oviparous form occurs on the sedge at the same time as the males, and these forms are present depositing eggs until cold weather.

First instar. General color dusky with dark appendages. Antennæ of four segments with measurements as follows: Segment I,

0.032 mm.; II, 0.032 mm.; III, 0.128 mm.; IV (0.032 mm.+0.176 mm.). Beak reaching to the hind coxæ, cornicles 0.048 mm.

Second instar. Similar to the last in general color. Antennæ of five segments with the measurements as follows: Segment I, 0.048 mm.; II, 0.048 mm.; III, 0.112 mm.; IV, 0.08 mm.; V (0.048 mm.+0.224 mm.). Cornicles 0.08 mm. Beak reaching beyond the second coxæ. Hind tibia 0.272 mm.

Third instar. General color similar to that of the previous instar, excepting that it is somewhat darker in color. Antennæ of five segments, with measurements as follows: Segment I, 0.064 mm.; II, 0.048 mm.; III, 0.176 mm.; IV, 0.112 mm.; V (0.048 mm.+0.272 mm.); cornicles 0.112 mm. Hind tibia 0.368 mm.

Fourth instar. General color similar to that of the last instar. Antennæ of six segments with measurements as follows: Segment III, 0.224 mm.; IV, 0.16 mm.; V, 0.144 mm.; VI (0.08 mm.+0.368 mm.). Segments imbricated but without secondary sensoria. Cornicles 0.192 mm. long, tapering, but slightly swollen on the distal third and distinctly imbricated and flanged. Hind tibia 0.64 mm. long; slightly swollen and thickly covered with nearly circular, tuberculate sensoria; length from vertex to tip of cauda 1.76 mm. Type in U. S. National Museum.

A NEW SPECIES OF EVANIA FROM THE CAMEROONS (HYMENOPTERA; EVANIIDÆ).

BY CHARLES T. BRUES,
Bussey Institution, Harvard University.

In working over a collection of Evaniidæ from South Africa, I have had occasion to examine a very interesting species from Western Africa. This was contained in a collection of Parasitic Hymenoptera given me by Prof. R. Thaxter, and the type has been deposited in the Museum of Comparative Zoölogy in Cambridge.

Evania flavocoxalis sp. nov.

Length 5 mm. Black, the antennæ brown at the base; palpi, four anterior coxæ and trochanters, anterior side of anterior tibiæ and posterior coxæ below, except at apex, yellow. Wings hyaline with a brown tinge. Body very thinly pubescent, almost

bare, except the hind tibiæ and tarsi which are more strongly pubescent than usual. Head rugosopunctate above the ocelli; front excavated gently above the antennæ, the basin finely longitudinally striate, space between it and the eyes more coarsely striate; between the antennæ is a strong carina that extends upward and disappears before the ocelli; beneath the antennæ is a transverse carina that curves upward outside them and extends halfway to the ocelli; face with deep striæ that converge below; cheeks with striæ that curve toward the base of the mandibles; head behind the eyes with scattered punctures of variable sizes, impunctate near the posterior edge and on the occiput except close to the ocelli. Cheeks half as long as the eyes, the inner edges of which are divergent below; ocelli close together in a low triangle, the

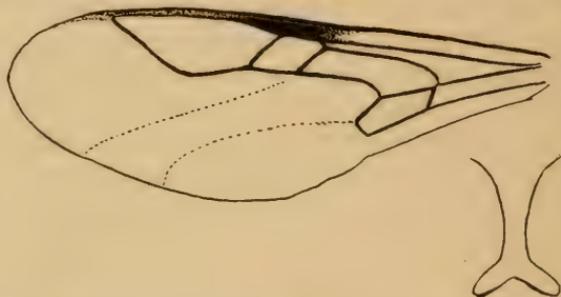


Fig. 1. *Evania flavocoxalis* sp. nov., fore wing and outline of metasternal process.

posterior ones larger than the anterior one, as far from one another as from the eye margin. Antennæ slender; third and fourth joints equal, each as long as the first two together and fully six times as long as thick. Mesonotum with distinct parapsidal furrows and with two other deep-grooved lines on each side external to the furrows; of these the inner one meets the furrow near its anterior end and the outer one meets the edge of the mesonotum just in front of the tegula; both attain the posterior margin of the mesonotum; surface of mesonotum irregularly punctate with coarse and fine punctures intermixed; smooth medially behind. Scutellum with large, well-separated punctures, smooth medially behind. Propodeum elongate, longer than the distance from its base to the anterior edge of the prothorax; not excavated behind, its posterior surface very gradually sloping, rounded off to the

base of the coxæ; evenly reticulate, coarsely so behind the insertion of the abdomen, finely so at the base. Pleuræ punctate-reticulate, the mesopleura with a long smooth space above that extends downward anteriorly. Metasternal process long and very narrow medially, its tines well-developed, widely divergent, and but slightly curved. Legs slender; hind coxæ microscopically transverse-reticulate; hind femora simple; hind leg not over twice as long as the body; longer spur of hind tibia half the length of the metatarsus. Petiole of abdomen coarsely obliquely striate except near the base. Wings with the basal vein lying closer than usual to the subcostal vein; cubitus arising very close to the junction of the basal and subcostal veins; nervulus interstitial with basal vein; radial vein meeting the subcosta at an acute angle; cubitus and subdiscoideus wanting beyond the cells. Hindwing with seven frenulum hooks.

This species is somewhat similar to *E. verrucosipes* Kieff. and might possibly be the male of that species which is known from the female only. However, the sculpture of the temples, scutellum, propodeum and petiole is entirely different and the thorax is nearly twice as long. From *E. cristatifrons* Kieff. also known from the female, it differs by the absence of the carina on the vertex and the pectinate process between the antennæ, by the sculpture of the petiole, and form of thorax. From *E. divergens* Kohl it is evidently distinct, although Kohl's description is very incomplete. The cheeks are shorter and the basal joints of the antennæ are much longer, and the color is different. The thorax is very much more elongate than in any other *Evania* that I have seen and the antennæ are more slender. The thorax is fully twice as long as high and the propodeum slopes gradually from base to tip, whereas it usually bends abruptly with an almost vertical posterior face.

THE BREEDING OF MOSQUITOES IN ALKALINE WATER.

BY H. L. BALLOWE.

Dr. C. S. Ludlow has sent the following note, quoted from a letter from Dr. H. L. Ballowe, Captain in the Medical Reserve Corps, U. S. Army at Fort St. Philip, Louisiana:

"A neighbor of mine at Buras, near the post, prepared a mixture of caustic soda to kill the San José Scale on his orange trees. After using a part of the barrel of the solution, the rest was left in a semi-protected location for about eight months. It was exposed to the weather and to some rains. On examining this barrel one day I found it teeming with larvæ and pupæ, both *Anopheles* and *Culex*. The alkali of the solution was marked to the taste, the color was a dark brown, and the solution affected litmus paper. I procured several jars of this solution and allowed the pupæ to complete development. The adults were seemingly normal."

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Wanted: Psyche, Vol. IX, No. 300 (April, 1901). Address, giving price, Librarian, Stanford University, Cal.

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Wanted: Insects of any order from ant nests, with specimens of the host ants, from any part of the world; also Cremastochilinae of the world. Will give cash or Coleoptera, Hymenoptera and Diptera from the United States.—Wm. M. Mann, Bussey Institution, Forest Hills, Boston, Mass.

Want to correspond with collectors of Noctuidæ in Northern Massachusetts. Subject to supply will pay any reasonable price for good specimens *Catocola sappho*.—Howard L. Clark, P. O. Box 1142, Providence, R. I.

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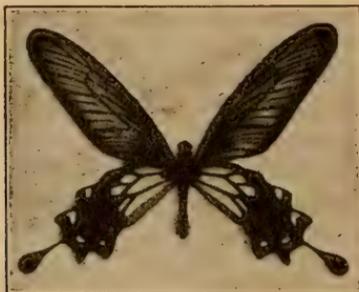
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No. 5

A EUROPEAN TERMITE *RETICULOTERMES LUCIFUGUS* ROSSI IN THE VICINITY OF BOSTON.

BY ROBERT JAMES DOBSON.

Bussey Institution, Harvard University.

In early May of the present year (1918) I was collecting termites in the vicinity of Boston in order to carry out some experiments at the Bussey Institution. Only one species of termites has been known to occur in this part of the country north of New Jersey, viz., *Reticulotermes flavipes* Kollar. I was surprised therefore during these collecting trips to find a few colonies of *R. lucifugus*, one of the common European termites of the Mediterranean region. This species has not been found in North America before, though at least two of our Western species have been confused with it. One of these occurs in California and another in Texas and also in Kansas.

There are not yet sufficient data on which to base a theory of its occurrence here. It would be less remarkable had it been found further south where the climate differs less from that of its home in Southern Europe. The fact that it has not appeared in earlier collections would indicate that it is not widely distributed, and it is entirely possible that it has been accidentally introduced from Europe. Kellogg¹ records an instance of scores of termites of this species being found in the boards of some packing cases received at Stanford University from Germany.

The size of the colonies I have found, and the fact that one of them at least was headed by a large queen give evidence that they have been here for some years. On a wooded hillside in the outskirts of Boston where I found what appear to be several distinct colonies of *R. lucifugus* the species occurs side by side with *R. flavipes* and in approximately the same abundance. I have found the galleries of the two species within a few inches of each other.

¹Kellogg, Vernon L., *American Insects*, 1908, p. 108.

The various forms in the colony are in general somewhat smaller than the corresponding forms in a colony of *R. flavipes*, and the winged adults are readily distinguished from those of *R. flavipes* by the deeper pigmentation of the wings and the proximity of the ocelli to the compound eyes. Among the forms that I have obtained is a physogastric "true queen." The abdomen of this queen measures approximately three times the length of that of the winged adults at swarming time. "True queens" in this species have apparently been difficult to find in Europe, so much so that Grassi concluded they never occur in nature at the head of colonies, their place always being taken by "complementary" or "substitute" royal forms. In more recent years however a few have been recorded.

The habits of *R. lucifugus* have been described in some detail by several authors, notably Lespes,¹ Grassi and Sandias² and Feytaud.³ I will add here only the following brief notes on the dates of molting and flying of the winged sexual forms. On warm hillsides at Forest Hills and Stony Brook Reservation, nymphs of *R. flavipes* were found molting into winged adults in large numbers from May 5 to May 10, and were seen emerging from the colonies and flying on May 15, 17, and 19. The corresponding nymphs of *R. lucifugus* were molting in numbers to the adult state nearly a month later, May 30 to June 5, and were found flying as late as June 30. The flying of the latter was probably somewhat delayed by the prolonged cold weather in June. In 1917 *R. flavipes* swarmed in the early part of June in the colonies I was observing at Forest Hills. This corresponds with the backwardness of the season in that year. A typical swarm was witnessed on June 8.

The development to the adult state is apparently accomplished in *R. flavipes* as early in the spring as the weather will permit. The nymphs reach the last nymphal instar in the late summer or fall of the previous year and are to be found in abundance as early as the termites appear in the spring, the first of April at Forest Hills this year. At this time they keep to the outlying parts of

¹ Recherches sur l'organisation et les moeurs du Terme lucifuge. (1856) Ann. Sci. Nat. Zoöl., 4 série, t. 5.

² The constitution and development of the society of termites; observations of their habits; with appendices on the parasitic protozoa of Termitidæ and on the Embiidæ, (1893-4) translated by W. F. H. Blandford, Quat. Jour. Micros. Sci., vols. 39 and 40, new series. (1896-7).

³ Contribution à l'étude du terme lucifuge. (1912) Archives d'anat. microsc., t. 13.

the nest apparently to get the benefit of the warmth from the sun to hasten their development. This would appear to be the case also with *R. lucifugus* with the one exception that they do not reach the last nymphal instar in the previous season. I was impressed with the fact that early in May (May 11–15, 1918) when in the colonies of *R. flavipes* the nymphs of the winged adults had just passed through their final molt (see above) the corresponding nymphs in *R. lucifugus* colonies on the same hillside were molting into the last nymphal instar and did not pass through their final molt until some three weeks later. This difference is evidently correlated with the fact that the adults of the latter species fly later than those of the former. It will be interesting to know whether the same difference obtains between *R. flavipes* and *R. virginicus* in Virginia where Snyder finds the latter swarming a month later than the former.

I wish to express my indebtedness to Mr. Nathan Banks who identified my specimens as belonging to the species *R. lucifugus*.

EMPOASCA MALI LeB. ATTACKS MAN.

BY GEORGE G. BECKER,

Agricultural Experiment Station, Fayetteville, Arkansas.

On June 4, 1918, I was pricked several times on the arm by some leaf-hoppers which Mr. W. D. Gibson determined for me as *Empoasca mali* LeB. These insects were attracted to the light under which I was studying. The sting of these insects was very insignificant. I should say not more than half so severe as a mosquito bite. There was no swelling, irritation or other after effects. It seemed that this Jassid did not do much more than merely prick the skin. On being disturbed, the leaf-hoppers which I observed moved off a little distance and again inserted their beaks in my arm.

NOTES ON THE SPECIES OF THE GENUS *DIOCTRIA*.

BY CHARLES W. JOHNSON,
Boston Society of Natural History.

On a window of the Boston Society of Natural History, I obtained, June 28, 1916, a specimen of *Dioctria*, but being unable to identify it at the time it was set aside to await more material. On July 6, 1917, while walking along Rawson Road, Aspinwall Hill, Brookline, Mass., I caught four specimens of the same species—two males and two females. After a careful study and comparison with specimens in my collection from Lyndhurst, New Forest, England (σ^7 ♀) determined by E. E. Austin, I can only refer it to *Dioctria baumhaueri* Meigen. Wishing to see if the species was still to be found, I visited the place again this year (July 4) and captured five males and four females.

The sudden appearance and apparently restricted distribution of a species after so many years of careful collecting in the vicinity of Boston, would indicate a comparatively recent introduction, possibly on the root of some plants, many of which have in the past been imported. The species can be distinguished by the following diagnosis.

Dioctria baumhaueri Meigen.

Face black with silvery white tomentum, mystax white, front and vertex black, shining, antennæ black, third joint about as long as the first and second together. Thorax with a sparse yellow tomentum having two narrow lines of black, a transverse band of white tomentum on the pleura extends to the front coxæ, also with irregular patches above the middle and posterior coxæ, all the coxæ with long white hairs below. Abdomen black, shining. Front and middle legs yellow, a line on the upper side of the femora, tips of the tibiæ and tarsi black, posterior legs black, a spot on the under side of the femora at the base, and the base and tip of tibiæ yellow. Halteres light yellow, wings hyaline. Length, 9–10 mm.

In *PSYCHE*, vol. 24, p. 117, 1917, Mr. Nathan Banks described several new species, some of which were formerly confused with *Dioctria albius* Walker, but readily separated by the male genitalia. In going over my collection in connection with this paper, I have

noted a more extended distribution of some of the species and also the fact that two of the names used are preoccupied. In calling Mr. Banks' attention to this he said that he did not have access to the catalogues at the time and desired me to correct these in connection with my notes.

Dioctria brevis Banks.

This species has been taken by the writer at Mt. Tom, Mass., July 14, 1905; Delaware Water Gap, N. J., July 11, 1898, and Aquia Creek, Va., May 24, 1896.

Dioctria banksi nom. nov.

D. longicornis Banks, PSYCHE, XXIV, 118, 1917, not Meigen, 1820. Four specimens of this species were collected near Long Branch, N. J., June 9, 1913. A specimen from Philadelphia, Pa., (June 22, 1893), is also in my collection.

Dioctria sackeni Williston.

A specimen of what is undoubtedly the female of this species was taken by the writer near Ricketts, North Mt., Pa., June 9, 1898, at the same time and place that a male was also captured. It has the bright yellow tomentum of the face, front and thorax, and the yellow legs of the male, but the wings are uniformly hyaline with a slight yellowish tinge near the base.

Dioctria media Banks.

A single specimen of this species from Seattle, Wash., collected years ago by the late Professor O. B. Johnson is in my collection.

Dioctria henshawi nom. nov.

D. flavipes Banks, PSYCHE, XXIV, 119, 1917, not Meigen, 1804. The name *flavipes* being preoccupied in this genus, the species is dedicated to Mr. Samuel Henshaw who collected the type at Yakima, Wash., July 2, 1882.

MYRMECOPHILOUS INSECTS FROM CUBA.

BY WILLIAM M. MANN,
Bureau of Entomology, Washington, D. C.

A collection of myrmecophilous insects that I made in Cuba the past winter, though very small, includes several genera new to the fauna of that island. In addition to records of these, I have described a Clavigerid beetle, *Fustiger schwarzi*, sp. nov., from a specimen in the U. S. National Museum.

ORTHOPTERA.

Myrmecophila americana Sauss.

Guantanamo; Cienfuegos.

I am following Schimmer (Zeitschr. wiss. Zoöl. Bd. xciii. Heft. 3, p. 432) in considering this to be the same as *M. prenolepidis* Wasm.

My specimens were taken with *Prenolepis longicornis* Latr., the usual host. Besides its wide-spread distribution *M. americana* is interesting in that it lives only with this one species of ant, instead of taking up with almost any species, like our North American forms do. Assmuth (Zeitschr. f. wiss. Insektenbiol. 1907, Bd. iii, p. 363-364) has given an interesting account of the moving of a colony of the host ant to a new nesting site. The crickets and the beetle, *Coluocera madera* Woll. accompanied the ant column and entered the new nest with it. *Myrmecophila* does not always leave a nest when the hosts do, for specimens are frequently found in formicaries that have been deserted by the ants. In connection with the local distribution of *Myrmecophila* the following note is of interest.

On Plummer's Island, Maryland, in an open-air insectary, several cigar boxes used as breeding cages had been left for some time on a high shelf. When I looked into these I found them tenanted by populous colonies of *Crematogaster lineolata* Say, and with these, several adults of *Myrmecophila pergandei* Scud. The crickets had either climbed the five feet of pole that held the shelves, or they had been transported by the ants, perhaps as immature phases. I think the latter more probable, chiefly because of some observations made on a related species of cricket on various islands in the Southwest Pacific. I found the cricket abundant,

and often on small isolated and deserted coral islands where one wondered how even the host ant could have reached and established itself.

HEMIPTERA.

Rhitidoporus indentatus Uhler.

Mina Carlota, Trinidad Mts.

Two specimens taken in a flourishing colony of *Solenopsis geminata* Fabr. indicate that this species resembles some of our North American species of *Thyrecoris* in having myrmecophilous tendencies.

COLEOPTERA.

Fustiger schwarzi sp. nov.

Length, 1.50 mm. Color reddish brown, the elytra somewhat lighter than the rest. Head nearly three times as long as broad; as broad in front as behind; sides subparallel; front transversely impressed between the eyes; occipital corners obtusely angulate, border feebly concave. Eyes small and convex, located at middle of sides of head. Antennæ one and one-fourth times as long as head; terminal joint slightly concave at middle, thickened at apical half, the end broadly rounded. Prothorax as broad as long, with a large median fovea along basal half; sides evenly convex. Elytra taken together about as long as broad, broadest behind, with narrowly rounded humeral angles and convex sides. Abdomen very deeply impressed transversely at base, tuberculate on either side and with a rather scant brush of yellow hairs. First segment margined at sides for entire length. Propygidium nearly four times as broad as long.

Shining. Head, antennæ and basal third of elytra foveolately punctate. Abdomen minutely punctate above, the ventral surface with abundant rather coarse punctures, fine recumbent white hairs moderately abundant everywhere except on abdomen.

Described from a unique female taken at Cayamas, Cuba, January 2, 1904, by E. A. Schwarz. It was in the nest of an ant of which no specimens were preserved.

Type No. 21569. U. S. N. M.

Coluocera maderæ Woll.

Cienfuegos.

Several specimens from one nest of *Prenolepis longicornis* Latr.

HYMENOPTERA.

Orasema minutissima Howard.

Mina Carlota, Trinidad Mts.

Several pupæ and adults were found in a hollow twig, with a colony of *Wasmannia auropunctata* Roger.

Acanthopria crassicornis Ashm.

Santiago de Cuba.

A single specimen taken in a nest of *Cyphomyrmex rimosus* Spin. var. *minutus* Mayr. agrees closely with the type from Grenada.

DISTRIBUTIONAL NOTES ON NEW ENGLAND
ODONATA.

PART II.¹

BY R. HEBER HOWE, JR.,

Thoreau Museum, Concord, Massachusetts.

The following additional records for Vermont are based on another small collection sent me by Mr. D. Lewis Dutton from Brandon. The specimens were captured in July, 1916.

Lestes unguiculatus Hagen; new to Vermont.

Lestes uncatus Kirby; new to Vermont.

Argia violacea (Hagen); new to Vermont.

Nehalennia irene (Hagen); new to Vermont.

Amphiagrion saucium (Burm.); new to Vermont.

Enallagma hageni (Walsh); new to Vermont.

Æshna verticalis (Hagen); new to Vermont.

Libellula pulchella Drury; new to Vermont.

The following record is new to Concord, Mass., bringing the known species from this township to sixty-eight.

Argia masta Hagen. Female taken August 15, 1916, and previously overlooked.

¹The figures in the chart of the Zygoptera published with this paper originally appeared in the author's manual of Odonata of New England, Parts I-II (Memoir of the Thoreau Museum of Natural History, II; 1-23, 1917. They are republished dichotomously here, because of numerous requests that they be available in the present form, and where they will reach more students of Odonata through the larger circulation of Psyche.

ODONATA

Zygoptera: Damselflies



Nodal vein of fore-wing arising near or beyond 5th postcubital.

Nodal vein of fore-wing arising not beyond 4th postcubital.

Anisoptera: Dragon Flies



♂

♂ and ♀ bronze green above, abdomen slender.



♀

♂ and ♀ red and black above, abdomen stout.



♂ and ♀ blue and black above.

Color pattern of thorax and base of abdomen of ♂'s as seen from above. also 3rd segment of ♀'s abdomen showing relative diameter drawn to scale.

Anomalagrion



Pterostigma of male not touching the costa of fore wings.

♀'s with less than 7 postcubitals.

Ischnura



Pterostigma of male touching the costa on fore wings.

♀'s with more than 7 postcubitals.

ODONATA

Zygoptera: Damselflies



Wings closed when alighted.

Anisoptera: Dragon Flies



Wings open when alighted.



Eyes widely separated, by more than the full width of an eye.



Eyes approximate, separated by less than half the width of an eye.

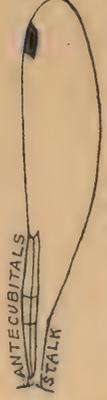
(See later key to Anisoptera: Dragon Flies.)

Agriionidae



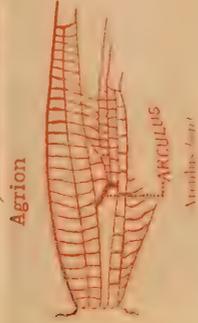
Five or more antecubitals. Wings not stalked.

Coenagrionidae



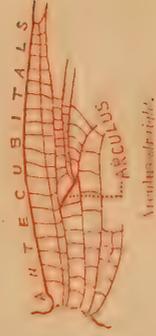
Two (rarely three) antecubitals. Wings stalked.

Agriioninae

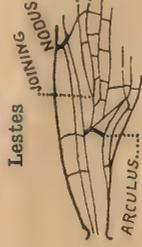


Agriion

Hetaerina

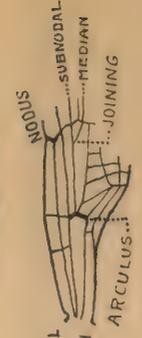


Lestinae

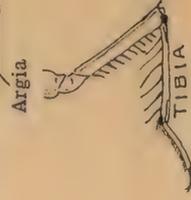


Subnodal and median veins joining nearer the arcus than the nodus.

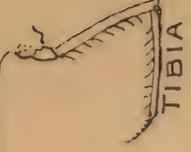
Coenagrioninae



Subnodal and median veins joining nearer the nodus than the arcus.



Hairs on tibia twice as long as the spaces between the hairs.



Hairs on tibia nearer twice as long as the spaces between the hairs.



Pale spots (rarely connected by pale narrow line) on top of head.



No pale spots on top of head.

Enallagma



Nodal vein of fore-wing arising near or beyond 5th postcubital.



Nodal vein of fore-wing arising not beyond 4th postcubital.

Ischnura



Pterostigma of male touching the costa on fore wings.

♀'s with more than 7 postcubitals.

Anomalagrion



Pterostigma of male not touching the costa of fore wings.

♀'s with less than 7 postcubitals.

Nehalennia



♂ and ♀ bronze green above, abdomen slender.

Amphiagrion



♂ and ♀ red and black above, abdomen stout.

Chromagrion



♂ and ♀ blue and black above.

Color pattern of thorax and base of abdomen of ♂'s as seen from above, also 3rd segment of ♀'s abdomen showing relative diameter drawn to scale.

The following records were found represented by specimens in the collection of the Museum of Comparative Zoölogy, Cambridge, Mass., and are here recorded with the permission of Dr. Samuel Henshaw.

Lestes unguiculatus, White Mountains; new to New Hampshire.

Enallagma aspersum (Hagen), Norway, Me.; new to Maine.

Ischnura posita (Hagen), White Mountains; new to New Hampshire.

Ischnura ramburii Selys, Canton (Mass.²); new to Massachusetts.

The following records I am permitted to record by Dr. R. P. Currie based on material in the U. S. National Museum.

Lestes eurinus Say, Burchard's pond, Fairfield Co., Conn.; new to the State.

Lestes congener Hagen, Franconia, N. H.; new to State.

Enallagma aspersum Devil's Garden, Fairfield Co., Conn.; new to State.

154. *Boyeria grafiana* Will., Cummington, Mass., July 5, 1889, collected by F. Knab.; new to New England.

155. *Tetragoneuria costalis* Selys, Manchester, Me., June 9, 1898, collected by Wadsworth; new to New England.

Tramea carolina (Linn.), Fairfield Co., Conn.; new to State (see *ibid.*, Part I).

Sympetrum costiferum (Hagen), Franconia, N. H.; new to State.

Celithemis eponina (Drury), Litchfield Co., Conn.; new to State.

Perithemis domitia tenera (Say), Fairfield Co., Conn.; new to State.

Erythemis simplicicollis (Say), Fairfield Co., Conn.; new to State.

Pachydiplax longipennis (Burm.), Fairfield Co., Conn.; new to State (see *ibid.*, Part I).

On January 3, 1917, through the kindness of Dr. Frank E. Lutz of the American Museum of Natural History, New York City, I was able to examine the collection of Odonata for New England material. I was also introduced by Dr. Lutz to Mr. Lewis B. Woodruff who had collected all but four of the New England dragon-flies found in the Museum's collection. Later I visited Mr. Woodruff who kindly permits me to publish the following records which were gleaned in an examination of his private col-

lection. Mr. Woodruff's collecting in New England has practically all been done at Litchfield, Conn., and he adds fifty species to the State list as given by Dr. Calvert, and one new species to New England.

Agrion amatum (Hagen) Litchfield, June 29, to July 14. The capture of this very rare species, new to Connecticut, was recorded by Mr. Woodruff in the Jour. N. Y. Ent. Soc., 22: 155, 1914.

Agrion aquabile (Say) Litchfield; new to the State (recorded *ibid.* 155).

Agrion maculatum Litchfield, with the above records from the Boston Society of Natural History; new to the State.

Lestes congener Litchfield; new to the State.

Lestes disjunctus Litchfield; new to the State.

Lestes rectangularis Litchfield; new to the State.

Lestes vigilax Litchfield; new to the State.

Argia mæsta Litchfield; new to the State (recorded *ibid.* 157).

Chromagrion conditum (Hagen) Need., as *putrida* (Hagen) Litchfield; new to the State (recorded *ibid.* 157).

Nehalennia irene Litchfield; new to the State.

Enallagma ebrium Litchfield; new to the State (recorded *ibid.* 157).

Enallagma civile Litchfield; new to the State.

Enallagma exsulans Litchfield and West Hartford; new to the State (recorded *ibid.* 157).

Enallagma signatum West Hartford and Block Island, R. I.; new to both States.

156. *Enallagma carunculatum* Morse Litchfield; new to New England.

Ischnura posita Litchfield; new to the State.

Hagenius brevistylus Litchfield; new to the State.

Gomphus johannus Need. Litchfield; new to the State. This was recorded by Mr. Woodruff in the Jour. N. Y. Ent. Soc., 22: 61-63, 157, 1914).

Gomphus albistylus (Hagen) Need. Litchfield; new to the State (recorded *ibid.* 22:157).

Gomphus brevis Hagen Litchfield; new to the State (recorded *ibid.* 22:157).

Gomphus sordidus Hagen Litchfield; new to the State.

- Gomphus spicatus* Litchfield; new to the State.
- Dromogomphus spinosus* Litchfield and West Hartford; new to the State.
- Cordulegaster diastatops* Litchfield; new to the State (recorded *ibid.* 22:156).
- Anax junius* Litchfield; new to the State.
- Æshna clepsydra* Litchfield; new to the State.
- Æshna canadensis* Litchfield; new to the State.
- Æshna umbrosa* Litchfield; new to the State.
- Æshna verticalis* Litchfield; new to the State.
- Æshna tuberculifera* Litchfield; new to the State, also in the Museum, collected at Provincetown, Mass., by J. L. Sabriskie.
- Basiæshna janata* Litchfield; new to the State.
- Boyeria vinosa* Litchfield; new to the State.
- Didymops transversa* Litchfield; new to the State.
- Tetragoneuria cynosura* Litchfield; new to the State.
- Tetragoneuria cynosura* var *simulans* Litchfield; new to the State.
- Tetragoneuria spinigera* Litchfield; new to the State.
- Helocordulia uhleri* Litchfield; new to the State.
- Somatochlora tenebrosa* (Say) Selys Litchfield; new to the State.
- Cordulia shurtleffi* Litchfield; new to the State.
- Dorocordulia libera* Litchfield; new to the State.
- Libellula pulchella* Litchfield; new to the State.
- Libellula luctuosa* Litchfield; new to the State.
- Sympetrum rubicundulum* Litchfield; new to the State.
- Sympetrum vicinum* Litchfield; new to the State.
- Sympetrum costiferum* Litchfield; new to the State.
- Leucorrhinia frigida* Litchfield; new to the State (recorded *ibid.* 22:158).
- Leucorrhinia intacta* Litchfield; new to the State.
- Celithemis elisa* Litchfield and New Hartford; new to the State.
- Celithemis eponina*, Block Island, R. I.; new to the State.
- Perithemis tenera* Litchfield; new to the State (see above).

Prof. A. P. Morse of Wellesley College, Wellesley, Mass., has kindly sent me the following records with permission to publish the same in this paper:

- Lestes inæqualis*, Sherborn, Mass.; new to the State (see *ibid.*, Part I).

Enallagma exsulans, Sherborn, Dover, and Medfield, Mass.; new to the State with the above records.

Enallagma ebrium, Brattleboro, Vt.; new to the State.

Amphiagrion saucium, Montgomery, Vt.; new to the State (see above).

Cordulegaster diastatops, Jay and Troy, Conn.; new to the State with Mr. Woodruff's records.

Boyeria vinosa, Wolcott, Vt., July 23; new to the State.

Libellula auripennis, Niantic, Conn., August 8; new to the State.

Sympetrum rubicundulum, Newport, Vt.; new to the State (see *ibid.*, Part I).

Sympetrum semicinctum, North Haven, Conn.; new to the State.

Erythrodiplax berenice, Niantic and Stamford, Conn.; new to the State (see *ibid.*, Part I).

The following record is represented by a specimen in the Boston Society of Natural History:

Erythrodiplax berenice (Drury), Barrington, L. I., June; new to the State.

Species known to Maine = 99.

Species known to New Hampshire = 97.

Species known to Vermont = 26.

Species known to Massachusetts = 123.

Species known to Rhode Island = 27.

Species known to Connecticut = 72.

SOME VARIATIONS IN THE GENUS VANESSA (PYRAMEIS.)

BY FORDYCE GRINNELL, JR.

The following notes on some very significant variations of the species of *Vanessa* (*Pyrameis*), originated from a series found in the collection of Mr. James E. Cottle of San Francisco. Other specimens, also representing the same variations, are in the collections of Mr. J. D. Graves of Oakland, Mr. J. C. Huguenin of San Francisco, and a few from the writer's collection have been deposited with the series in Mr. Cottle's collection. The illustration represents those in Mr. Cottle's collection and captured by him.

***Vanessa* (*Pyrameis*) *caryæ* Hübner.**

This species is well known in its typical form as figured by Holland, Wright, Letcher and Essig. Its range extends along the Pacific Coast from Vancouver and British Columbia to Chili, being especially abundant in California. It is recorded in Skinner's Catalogue from "Ariz., Nev., Utah," but I have seen no specimens from these regions, and do not know of any authentic records. Nor have I seen any specimens from the western coast of South America, where a knowledge of the variations would be of particular interest in the evolutionary study of the species. The species varies in size but there seems to be no correlation between the size and marking variation. The normal or typical *caryæ* seems to be characterized especially by the extent of the black markings of the primaries and the large submarginal black eye spots of the secondaries, only slightly pupilated with bluish scales, not white.

***Vanessa caryæ* var. *muelleri* Letcher.**

This variation as described by Letcher (4) varies from the normal form of *caryæ*, which is the commonest, in the extension of the fulvous color of the basal portion of the forewings and the nearly complete elimination of the black markings in this area. The apical white spots develop into dashes extending towards the outer margin. The large fulvous spot or series of spots in the costo-apical black field is still present. There is an additional large fulvous patch or two patches (usually) just below the row of apical white spots. The black marginal band is connected with the costo-apical black area by a rather broad black area. On the secondaries the black encircled blue spots become white or bluish-white, and there is a slight extension of the black in the upper portion. The specimens figured by Essig are not this but belong to the following variation.

Of the typical *muelleri* variation I have seen specimens from the following localities:—LaFayette Square, San Francisco, August 1914 (Cottle); Los Angeles, July 1915 (Karl Skolfield); 18th Street Square, San Francisco, October 8, 1917 (Huguenin); San Francisco, October 17, 1917 (Huguenin).

***Vanessa caryæ* var. *intermedia* var. nov.**

This intermediate variety between the typical *caryæ* and typical *muelleri* differs in having basal traces or remnants of the black

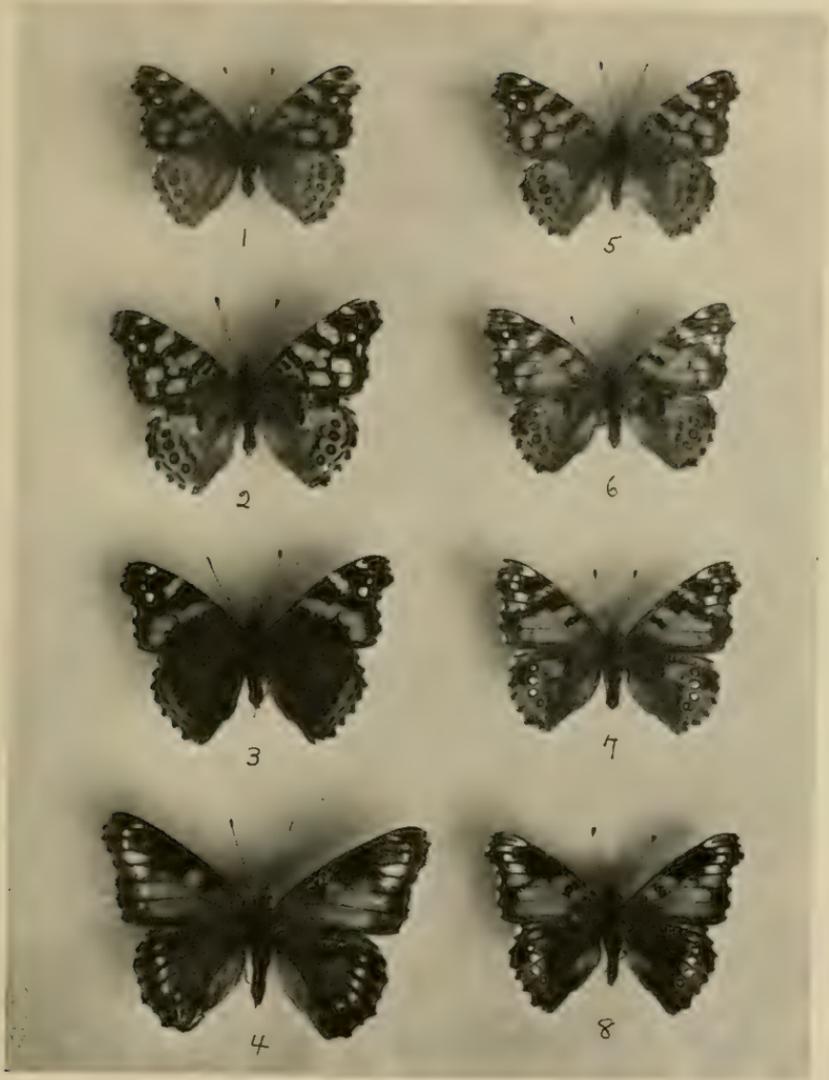
markings in the fulvous replacement of the forewings; and a broad black band on the upper half of the outer margin of the hindwings. It still keeps the row of black-encircled blue-centered eye spots on the hindwings. The larger fulvous spot below the apical row of white spots is large. The fulvous patch in the costo-apical black area is still present. I have before me three specimens from the following places:—Berkeley, August 3, 1917 (Graves); November 5, 1911 (Graves); San Francisco (Cottle); San Francisco, October 10, 1917 (Huguenin).

Vanessa caryæ var. *letcheri* var. nov.

The striking difference from *muelleri* lies in the *entire* disappearance of the fulvous spots or band of spots in the costo-apical black area, leaving a solid black, quadrangular area. The two fulvous patches below the apical row of white spots are much larger, and nearer the larger, basal fulvous area, leaving only a narrow black connection to the quadrangular black area and wider black outer margin. The basal portion of the hindwings is blacker than in *muelleri*. The following specimens have been examined:—Castella, Shasta Co., June 1913 (Cottle); Berkeley, July 20, 1917 (Graves); July 30, 1917 (Graves); Los Angeles, July 1915 (Harold Burkhardt); Los Angeles, July 1915 (Karl Skolfield); 18th Street Square, San Francisco, September 24, 1917; Oakland, September 4, 1917; October 9, September 17 (Huguenin).

In all these variations the black discal dash in the costal side of the large fulvous area of the primaries remain practically unchanged; all the other markings become more or less altered.

In 1898 the variety *letcheri* was apparently not known in collections and the variety *muelleri* was "very rare," but Letcher mentioned the fact that Mueller had some intergrades between *caryæ* and *muelleri* in two directions; one is like the one here named *intermedia*, and the other with the blue spots of the secondaries replaced by white and without any change in the primaries. The apical white spots are either blurred, smaller, or lengthened out in the direction of the apex, and indefinite. These remarkable and significant variations seem to be increasing and tending in the direction of *letcheri*. Letcher recorded the variations known to him as taken only in the fall, but they are now known to be found throughout the year.



GRINNELL—Variations in the Genus *Vanessa*.

As Letcher surmises, in the case of *muelleri*, this variation may be "an example of the evolution of a true variety time only will tell." At any rate since 1898 the variations have become more common, *letcheri* the commonest, and are very suggestive from an evolutionary standpoint. We must watch the behavior of these variations still more in future years.

Essig (1) figures two specimens of *letcheri* as *muelleri*. Here we have a series extending from typical *caryæ*, through *intermedia* and *muelleri* to *letcheri*, showing a progressive evolution. Mr Cottle took two other specimens of *caryæ* in Lafayette Square, San Francisco, showing an interesting variation, but they do not belong in the same category as the above variations. One of these has the primaries of the usual light coral red color, while the hindwings are of a light coral pink or a washed-out appearance. The other specimen has the usual color of all the wings replaced by a light flesh-pink (Ridgway).

Vanessa cardui Linn. var.

Expanse 66 mm. This very striking variation of a cosmopolitan butterfly bears a very close resemblance to *letcheri*, as can be seen, and is very nearly like that of *cardui* figured by Newman (5) from England. There is a submarginal row of comparatively large white spots on the primaries, the two middle ones being the largest; also a similar row of white spots on the secondaries which are of the same size. The outer ends of the veins of the hindwings are bordered wholly with black. And the middle region of the hindwings is of the same fulvous color as the ground color of *letcheri*.

Now *cardui* is a cosmopolitan butterfly while *caryæ* is restricted to the Pacific side of the two Americas, and the most restricted of all the *Vanessas* (*Pyrameis*); but here we have a form which occurs in *cardui* of the same pattern as the seemingly more recent one in *caryæ*. These sports, aberrations, or what is better to call them, variations of a different degree, are of more significance in the evolutionary history of species than seems to be generally supposed. We have here, probably, a good example of orthogenetic variation or a definitely directed evolution.

Vanessa atalanta Linn. var. *edwardsi* var. nov.

Expanse 56 mm. The wide band or series of quadrate spots across the primaries is an apricot-orange (Ridgway) instead of a

carnelian red as in typical *atalanta* and the costo-apical or subapical white patch of *atalanta* is a salmon-buff in this variety. There are four white apical spots. The outer margin of the hindwings are of an apricot-orange; the basal portion of the primaries and secondaries is of a bordeaux red (rusty red) instead of a deep purplish black as in *atalanta*. There is a submarginal row of black spots on the hindwings in the same position as those of *carye*. The underside more nearly resembles *atalanta*. In its characters this variation partakes of the aspects of both *carye* and *atalanta*. Henry Edwards (3) records a specimen of what he speaks of as a hybrid between *carye* and *atalanta*. The description of his specimen resembles mine very closely. The submarginal row of spots had white pupils while mine has none, except a very faint trace in two of them. Henry Edwards' specimen was raised by Dr. Behr from the larva from Lagunitas, Marin Co., July 1876; while Mr. Cottle's specimen was caught flying at Buchanan and Washington Streets, San Francisco, in August 1914. So there is quite a time interval in the capture of these two similar variations, but in a short distance geographically. This is a very interesting variation, which we are hardly justified in calling a hybrid, and undoubtedly has some evolutionary significance.

As an excuse or an explanation for naming these new variations it is well to say that it is particularly useful to know as much about the variations of a species as possible, especially now, when so much is being said of the order of evolution; whether it is indiscriminate or directed or whether it may follow both paths. It is only by the accumulation of definite data concerning variations that we can arrive at a correct idea of the order of evolution in a given species. It is the method we want to know, and there is no more intricate problem confronting us.

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EXPLANATION OF PLATE.

1. *Vanessa carye* var.
2. *Vanessa carye* var.
3. *Vanessa atalanta* var. *edwardsi* n. var.
4. *Vanessa cardui* var.
5. *Vanessa carye* normal.
6. *Vanessa carye* var. *intermedia* var. nov.
7. *Vanessa carye* var. *muelleri* Letcher.
8. *Vanessa carye* var. *letcheri* n. var.

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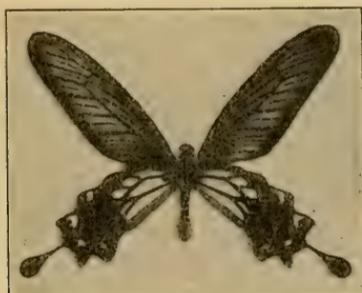
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ON THE STRUCTURE AND FUNCTION OF THE PROVENTRICULUS OF *GRYLLUS PENNSYLVANICUS* BURM.

BY E. MELVILLE DUPORTE,
Macdonald College (McGill University), Canada.

There are two explanations generally given of the function of the proventriculus in insects. The earlier writers regarded this organ as the analogue of the gizzard of birds, an organ for the mastication and comminution of the food in its passage from the crop to the mesenteron, hence the terms "gizzard," "gesier," "Kaumagen."

Another view, and one which perhaps has now the greater number of adherents, is that the teeth of the proventriculus have no triturating function but act as a strainer or grating to exclude solid particles of food from the mesenteron. While some writers deny completely the comminuting function of the proventriculus, others are willing to admit that in addition to its straining action it may sometimes have a triturating action. Still others hold that one of the chief functions of this organ is to thoroughly mix the food from the crop and prepare it for the action of the digestive juices in the mesenteron.

The writer hopes to show from a study of the structure of the proventriculus of *G. pennsylvanicus* and of the condition of the food in the crop, the proventriculus and the mesenteron, that in the Gryllidæ the proventriculus has a definite triturating function. The descriptions are limited to *G. pennsylvanicus* because for his purpose the armature of the proventriculus in all of the Gryllidæ studied by him is essentially similar.

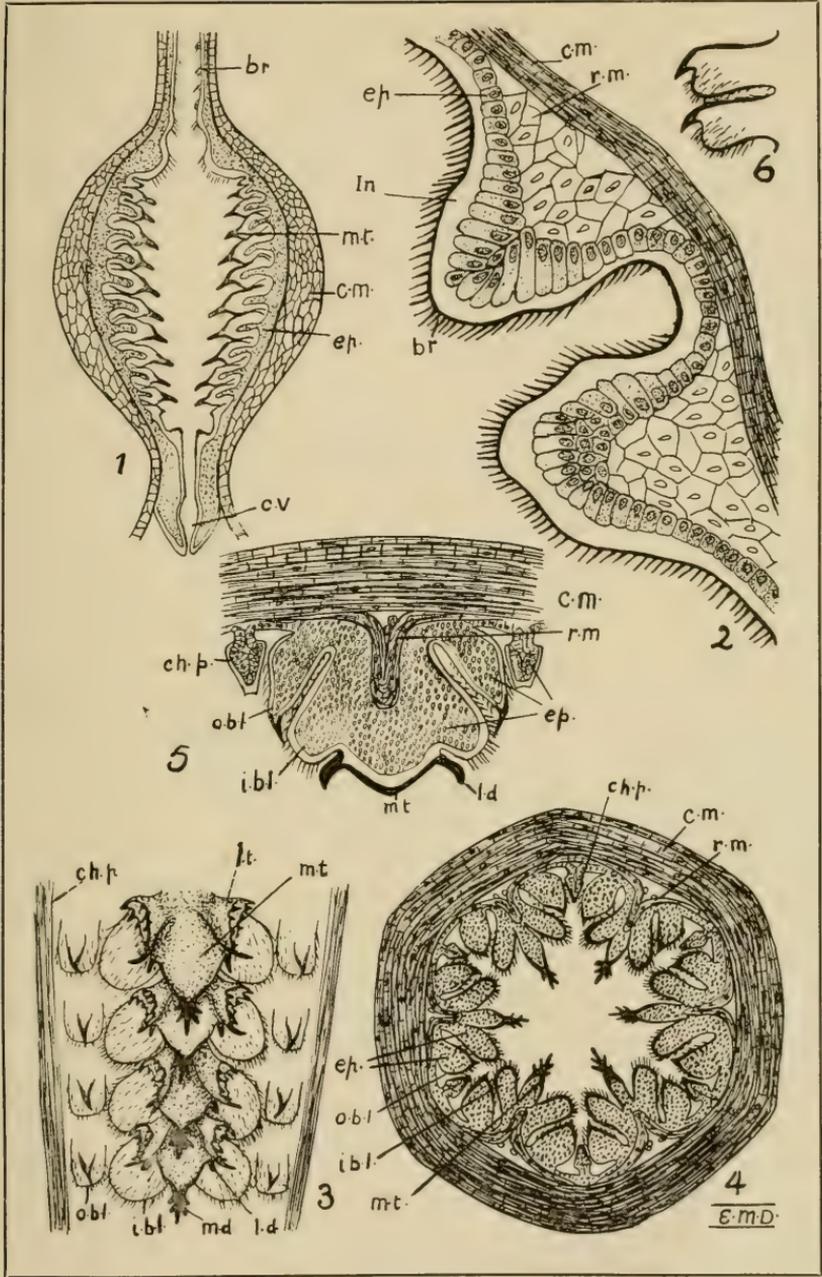
As the proventriculus of other species of the Gryllidæ has already been described the structure will not be given in very great detail.

The anterior division forms a tubular neck leading from the crop. The intima is thrown up into six folds each bearing ten

transverse rows of backward-directed bristles (Pl. V, br.), a few of these bristles, especially in the posterior rows, occasionally develop into small chitinous teeth. The tunic of circular muscles (c. m.) is only two or three layers thick and in each fold there is a band of longitudinal muscles (Pl. V, Fig. 2. r. m.).

The posterior division of the proventriculus is broadly oval and contains a complicated system of strongly chitinized teeth. The tunic of circular muscles is well developed, consisting in some places of ten or twelve layers. Within are six dental folds continuous with the folds in the anterior portion. These folds are separated by means of chitinous partitions (Pl. V, ch. p.). In each dental fold there are normally ten transverse rows of teeth, each row consisting of seven distinct teeth all directed backward towards the mesenteron. In the middle of the fold is the median tooth (m. t.), the only unpaired tooth in the row and the one which projects farthest into the lumen. At its apex it bears four to six sharply pointed, strongly chitinized median denticles (Pl. V, m. d.) and at each of its basal angles a single sharp lateral denticle (l. d.). Immediately in front of the median tooth is a pair of lateral teeth (l. t.); viewed from the inner side (*i. e.*, from the direction of the median tooth) these teeth are narrowly wedge-shaped; from the outer side they present a narrow curved surface around the edge of which are arranged eight small chitinous processes which convert this tooth into a grinder comparable to a molar. Behind the median tooth is a pair of large blunt pad-like processes (i. b. l.) not very highly chitinized as compared with the median and lateral teeth, and covered for the most part with a short yellow pubescence but on the anterior side with rather longer and stiffer hairs. Next the chitinous partition on each side is another brush-like process (o. b. l.) bearing a very sharp backward curving tooth. The two last described processes are termed by Berlese *i lobi a spazzola* so the writer has called them respectively the inner and outer barbated lobes.

The cells of the single epithelial layer of the chitinous partitions are clearly marked off. The epithelial cells of the various processes are not so distinctly marked, the numerous nuclei of the epithelium being very closely packed. Within each row of teeth there is a muscular band (Pl. V, Figs. 4 and 5 r. m.) which pulls the teeth outwards, enlarging the lumen and opposing the action of the circular band.



DUPORTE—Proventriculus of Gryllus.

Examination of the structure of the proventriculus with its complicated system of teeth—the sharp denticles fitted for cutting and tearing, the lateral teeth fitted for crushing and grinding—and its efficient mechanism for powerful compression can hardly fail to convince one that this organ has a definite triturating function; but the evidence does not lie in the structure alone but also in a consideration of the condition of the food in the crop, the proventriculus and the mesenteron.

Plateau, one of the foremost and most authoritative exponents of the theory that the proventriculus is exclusively a strainer, has shown in support of his contention that if a cockroach feeds on food rich in cellulose, which is not digestible in the crop, fragments are found unaltered as to form and size in the mesenteron. If it consumes an abundance of farinaceous food, starch granules which escape digestion in the crop are found uncrushed in the mesenteron. To the writer this evidence does not seem conclusive because if the proventriculus were efficient as a strainer, all large particles should be excluded from the mesenteron no matter what their nature, and we should find much solid food in the crop and only liquid food or finely divided solid food in the mesenteron. On the other hand, if the proventriculus has a masticating action, tough substances such as cellulose would be imperfectly triturated, while bits of food as small as starch grains might easily escape further comminution. The condition of the food in the different sections of the canal would depend on the nature of the food ingested. If the food is soft and easily crushed the contents of the crop and mesenteron will be similar to those described where the straining action is postulated. If the food contains hard or tough particles, not easily crushed, these will be forced through the proventriculus and solid particles of food will be found, not only in the crop, but also in the mesenteron.

An examination of the digestive canal of crickets which had been fed on miscellaneous food, including dead crickets and locusts, revealed the fact that the particles of chitin, quartz and woody tissue found in the proventriculus and mesenteron were fully as large as any found in the crop (Pl. VI, 1, 2, 3).

The crop of crickets which had been fed on dead insects contained large particles of soft animal tissue (Pl. VI, 4). The mesenteron contained only small pieces (Pl. VII). A similar re-

sult was obtained with crickets which had been starved for several days and then fed on grains of wheat. The crop contained large bits both of the hull and of the starchy endosperm. The mesenteron contained several large bits of hull but no pieces of endosperm as large as those in the crop (Pl. VII, 2, 3, 4).

It will be seen from the foregoing that as a grating for the exclusion of large particles from the mesenteron the proventriculus has, in the cricket, little or no efficiency, since it allows even fragments of quartz to pass through it. Indeed a study of the arrangement of the backward directed teeth and the strong muscular coat will make it evident that particles caught in the proventriculus will be forced towards the mesenteron. The action of the proventriculus might be compared with that of the rollers in a mill; anything caught between the rollers is carried onward, if it is strong enough to resist the breaking power of the rollers it will come out unaltered on the other side, if not it will be crushed.

In many insects the teeth of the proventriculus are so poorly developed that they can have little or no triturating action. In others this organ serves some special purpose as in the honey sac of the bee (Cheshire), or the combined pump and valve of the house fly (Hewitt). In the cricket, however, the structure of the proventriculus and the condition of the food after passing through it leave no room for doubt that this organ has a definite triturating function.

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Fig. 1



Fig. 2



Fig. 3



Fig. 4



Fig. 1

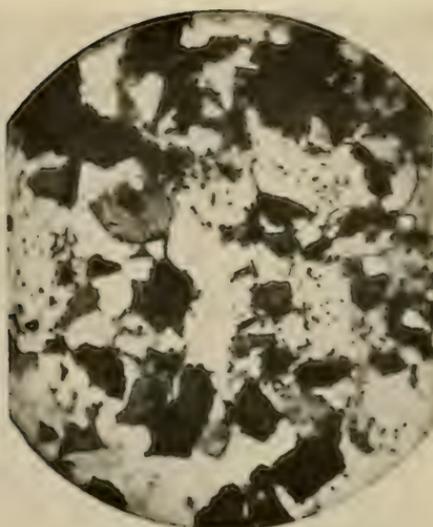


Fig. 2



Fig. 3



Fig. 4

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EXPLANATION OF PLATES.

Plate V. Sections through the proventriculus of *Gryllus pennsylvanicus*. All greatly enlarged.

- Fig. 1. Longitudinal section through the median denticles.
- Fig. 2. Transverse section passing through two folds of the anterior division of the proventriculus.
- Fig. 3. Surface view of a portion of one of the dental folds showing the chitinous partition and four of the transverse rows of teeth.
- Fig. 4. Transverse section of proventriculus passing through the median denticles.
- Fig. 5. Transverse section of fold cut in the region of the lateral denticles.
- Fig. 6. Lateral view of two adjacent inner barbated lobes.
- br. = Bristles of anterior division of proventriculus.
 ch. p. = Chitinous partition between dental folds.
 c. m. = Circular compressing muscles.
 c. v. = Cardiac valve.
 ep. = Epithelium.
 i. b. l. = Inner barbated lobes.
 in. = Intima.
 l. d. = Lateral denticle.
 l. t. = Lateral tooth.
 m. d. = Median denticles.

m. t. = Median tooth.

o. b. l. = Outer barbated lobes.

r. m. = Relaxing muscle.

Plate VI. Photomicrographs of the contents of the digestive canal of cricket. Figs. 1, 2, 3 crop, proventriculus and mesenteron of cricket fed on miscellaneous food. Fig. 4, crop of cricket fed on dead insects.

Plate VII. Fig. 1 mesenteron of cricket fed on dead insects. Figs. 2, 3, 4 crop, proventriculus and mesenteron of cricket fed on wheat grains.

NEW POLYDESMOID DIPLOPODS FROM TENNESSEE AND MISSISSIPPI.

BY RALPH V. CHAMBERLIN,
Museum of Comparative Zoölogy.

Of the following underscribed species of millipedes one was collected in Mississippi at Agricultural College by Mr. J. W. Bailey, while the other four, three of them pertaining to a new genus, were taken by Professor R. Thaxter at Burbank in eastern Tennessee. The new genus is segregated from *Fontaria* sens. lat.

Fontaria pela sp. nov.

This species when in full color is above deep shining black with the caudal corners of the carinæ and the tip of the last tergite in life apparently bright red, fading in alcohol to brown or orange. There may or may not be a narrow stripe of the same bright color across the anterior border of the first tergite. The lateral region of each somite is in the main reddish or orange brown with a black stripe down the caudal portion from carina to legs, and a less distinct dark stripe in some along the anterior border as well. The antennæ are somewhat chestnut and the legs are brown.

The body is proportionately rather slender. It is parallel-sided excepting at the ends which are narrowed. The lateral carinæ are moderate in size; the caudal margins of the anterior ones are bent forward, those of the middle region less so, and those of the posterior ones first straight and then bent caudad, the posterior angles of the

last three acutely produced in increasing degree. Carinæ all depressed.

Head smooth and shining. Vertigial sulcus distinct, ending between antennæ often in a weak pit-like depression, a more obscure sulcus running from here to each antenna, the two forming a very obtuse angle. No occipital foveolæ detected in types.

In the male the genital processes of the second coxæ are short and cylindrical. The sternites are without processes excepting for low paired rounded bulgings on the third, fourth, and fifth somites. Coxæ unarmed.

The gonopods of the male are strongly pilose with long hairs on the mesal side at base, while the coiled blade is more sparsely provided with very short hairs. The blade of each gonopod curves ventrad and then across the other one, again bending dorsad and then back toward its own side as far as the middle line where it curves again ventrad at its tip; it narrows gradually distad, becoming slender, but near the end expands a little into a slightly lanceolate head which is acute and at the base of which on the concave side is a short tooth or spine; it is flattened throughout. The basal spine is rather stout and somewhat flattened with the acute apex bent at right angles to the main axis, and in some showing also a small acute point in line with the latter.

The males are ordinarily obviously smaller than the females.

Length of type (male) about 34 mm.; width, 7.25 mm. Length of a female near 40 mm., with the width 9 mm. The maximum male is 41 mm. long and 8.5 mm. wide.

Locality: East Tennessee; Burbank. Numerous specimens collected by Dr. R. Thaxter.

Fontaria ochra sp. nov.

The types are in general fulvous, with the legs and antennæ yellow, in most somewhat darker across the anterior region of the somites, though in the darkest individual of all the darkest part of the somite is in a narrow stripe slightly in front of the caudal margin. The general color appearance is much like that of *F. crassicutis* Wood. The carinæ in some are somewhat paler than the intervening region.

Body obviously narrowed at both ends, the sides over most of the length being parallel or nearly so. Lateral carinæ moderately

large, not raised at angle to general slope of somites excepting in caudal region. Posterior margin of carinæ in anterior region straight, slightly bent caudad in middle region, more so in posterior region, but only the last few acutely angularly produced.

Vertigial sulcus distinct, ending abruptly at or a little above upper level of antennal sockets. Occipital foveolæ 2+2.

In the male the sternites and the coxæ are without special processes.

In the gonopods of the male the principal or distal division is stout at the base and narrows gradually distad; it extends ventrad and then curves across to the other gonopod and then coils dorsad; near the point where it begins the bend dorsad it is somewhat geniculate, the portion beyond the geniculation being more slender and somewhat doubly or sigmoidally curved with the acute tip bend mesad almost at right angles; it is densely pilose at base on the mesal side and less strongly so along the edge to near the level where the bend across to the other side begins. The basal process is short, straight and acute and extends obliquely caudomesoventrad to near the tip of the principal process of the opposite gonopod.

Length of type (male) about 35 mm.; width, 10 mm.

Locality: Mississippi: Agricultural College. Six specimens collected in the fall of 1916 by J. W. Bailey.

Nannaria gen. nov.

Genotype—*N. minor* sp. nov.

In addition to the type species, *Fontaria tennesseensis* Bollman, *N. media* sp. nov. and *N. infesta* sp. nov., described below, belong in this genus. These forms are all small in comparison with *Fontaria* and are characterized in the main by the structure of their male gonopods in which the principal process is rather short and nearly straight or only moderately curved, never coiled, and not ordinarily passing the median line or crossing that of the other side, and in which the basal process is relatively long and slender. The genus will be critically defined and discussed in another place.

Nannaria minor gen. et. sp. nov.

This is a small species comparable in size to *F. tennesseensis*. The general color of the dorsum in the types is a dull, in one speci-

men somewhat smoky brown with the lateral carinæ paler, yellowish. A dark median longitudinal dorsal line is evident in the posterior portion. Antennæ and legs yellowish.

A slender species narrowed decidedly at the ends but elsewhere uniform in width. The posterior margins of the anterior somites are bent back slightly, those of the succeeding ones in going caudad more and more strongly so. The posterior corners of the last three pairs of carinæ strongly produced caudad but not acute, the distal ends being strongly rounded, the corners of the others more angular.

Vertigial sulcus ending as usual at the angle of a transverse arcuate sulcus between the antennal sockets, the latter sulcus much weaker than the vertigial and becoming obscure toward the ends.

In the male the sternites in the region caudad of the gonopods are produced at the ends, adjacent to the legs, caudad into sharp, straight conical processes; on the anterior half of the fourth somite are two distally rounded, subconical processes. The genital processes of the second coxæ are slenderly conical and short and project subcaudad. Coxæ unarmed. In what is regarded as the female of this species the sternites are not produced but the coxæ of the middle and posterior regions are at their distal ends produced ventrad into acutely tipped conical processes which decrease in size in going cephalad.

The species is readily distinguished by the character of the male gonopods. The principal branch is above the basal joint subcylindrical to below middle of length where it is abruptly narrowed into a slender blade which is moderately curved, but not at all coiled, its acute tip meeting that of the opposite gonopod at the median line. The caudal branch is long though not quite reaching the end of the main branch; it presents a decided double or sigmoid flexure, the acute tip bending across that of the other one; at the level of the first flexure on the ventral side there is a short acute spur.

Length of type (male) near 27 mm.; width, 5.5 mm.

Locality: East Tennessee: Burbank. A male and female collected by Dr. R. Thaxter.

Nannaria media sp. nov.

When in full color this species is deep chestnut above with the posterior corners of the lateral carinæ yellow. Beneath the color

is yellowish brown. On each somite between carina and legs of each side two dark stripes, one anterior and one posterior in position. The legs are brown, the anterior ones more reddish or chestnut, the antennæ typically still deeper in color.

The body is slender as in *minor*. The posterior margins of the lateral carinæ in the anterior region are straight, in going caudad becoming more bent back as usual though none of the posterior corners are really produced excepting those of the last three pairs of carinæ. The processes of the last three pairs of carinæ are broad and blunt, but not so evenly rounded as in *minor*, the mesal edge between apex and base bulging more than in that species.

The vertigial sulcus is deep. It bifurcates into two weaker sulci below, these not forming a distinct arcuate sulcus, the ends not evidently approaching the sockets of the antennæ as transverse lines. Occipital foveolæ 2+2.

In the male none of the sternites bear processes in either the posterior or anterior regions. The processes of the second coxæ are very short and comparatively thick. Coxæ unarmed in both sexes.

The male gonopods in general similar to those of *minor* but the principal branch not abruptly narrowed below a cylindrical base, the process gradually narrowing from base to the apex and geniculate near beginning of distal third of length, the apex not meeting that of the other gonopod. The distal portion flattened in a sub-vertical plane, distally truncate with upper and lower corners minutely acutely produced; also a point below a little proximad of end. The posterior spine is very slender and finely acutely pointed, and is nearly straight above its base, running subparallel to the main process than which it is much shorter, but the extreme apex curving somewhat ectad.

Length of type (male) about 30 mm.; width, 5 mm.

Locality: East Tennessee: Burbank. Two males and a female collected by Professor R. Thaxter

Nannaria infesta sp. nov.

Carinæ and caudal borders of metazonites dilute red, probably bright red in life; metazonites elsewhere olive, the dark color intruding on the carinæ anteriorly; prozonites olive grey.

Body slender, more strongly narrowed cephalad and caudad than in media, the attenuation caudad being especially pronounced and gradual. The processes of the last carinæ shorter and much broader than in media; the processes of the two preceding segments differ in having the mesal margin much less oblique and more nearly symmetrical with the outer one, caudally rounded. The caudal extension of the posterior ends of the carinæ begins farther forward than in media.

Vertigial sulcus very deep, ending below on a level with the centers of the antennal sockets, not truly bifurcate though there is a vague fine line from its lower end to each antennal socket.

Sternites without processes.

Principal processes of gonopods gradually narrowing distad much as in media, but the glabrous distal region shorter and curving more abruptly and more decidedly mesad, the distal, subvertical edge not obtusely excised as in media. The minor dorsal (anterior) processes more slender than in media and not subparallel, extending each obliquely mesodistad.

Length of type (male) near 35 mm.; width, 5.5 mm.

Locality: North Carolina: Cranberry (Coll. Aug. 6, 1896. Rec'd for study through Prof. R. Thaxter.)

The type is abundantly infested with an *Empusa*. It is in the collection of the Department of Cryptogamic Botany at Harvard University.

A NOTE ON *LIMATUS DURHAMI* THEOBALD.

BY C. S. LUDLOW.

An interesting omission in the available descriptions of this species, so far as the English and American authorities at least are concerned, was brought to my attention by the receipt of specimens sent by Colonel W. H. Wilson, M. C., United States Army, from the Canal Zone.

Neither in Mr. Theobald's description¹ nor in that given by Howard, Dyar and Knab² is mention made of a very noticeable and

¹ Theobald, F. V., Monograph, *Culic*, II, p. 349. 1901. *Ibid.*, III, p. 333. 1903.

² Howard, Dyar and Knab, Monograph, *The Mosquitoes of North and Central America and the West Indies*, III, p. 40. 1912.

beautiful marking on the male proboscis, and because of this omission I was led to hope that a new species had been sent me. However, comparison with the males at the National Museum showed the same marking on the specimens there, and then I found in the description of *Simondella curvirostris* Lavéran¹ quoted in the monograph of H. D. & K. the following:

“Près de son origine elle est sombre à la face supérieure et présente, à la face inférieure un petit disque ovale garni d'écailles d'un bleu très vif.”

As a matter of fact this little oval group of scales is very brilliant and suggests a sapphire set in the dark proboscis.

As this marking seems to have escaped entirely the notice of both the authorities mentioned it is perhaps worth while to call attention to it.

Army Medical Museum,
Washington, D. C.,
August 14, 1918.

NOTES ON *CLOSTERO CERUS CINCTIPENNIS* ASHM.,² IN NEW JERSEY (HYMENOPTERA)

BY HARRY B. WEISS AND ALAN S. NICOLAY
New Brunswick, N. J.

This species not heretofore recorded from New Jersey has been found by us at the following localities: New Brunswick, Jamesburg, Highbridge, Trenton, Bridgeton and Plainfield, and undoubtedly occurs in many other places in the state. It was described by Ashmead in his paper “Descriptions of Some New North American Chalcididæ” which appeared in Vol. XX, p. 104-1888 of the “Canadian Entomologist” and the habitat given is United States. It is also listed in “The Hymenoptera or Wasp-like Insects of Connecticut” as probably occurring in that state. Neither of the above publications mentions the hosts.

In New Jersey we have found *C. cinctipennis* to be parasitic upon the eggs and larvæ of *Brachys ovata*, the eggs of *Brachys aerosa* and

¹ Laveran, C. R., heb. Soc. Biol., liv. 1160. 1902.

² Identified by A. B. Gahan.

the larvæ of *Phyllonoryter hamadryadella* and *P. ulmella*, all of which are leaf miners. Its habits are therefore similar to those of other members of the genus and allied genera. During the summer of 1918, it appeared to be more common in the *Brachys* eggs and the larvæ of *P. ulmella* than in the other hosts and only on one occasion was it bred from the larva of *Brachys ovata*. It constituted a serious pest in the eggs of *Brachys* sp., which we were trying to rear and was very common in the mines of *P. ulmella*. Adults of *C. cinctipennis* were most plentiful about the first week of July and the pupal stage required about two weeks.

The eggs of *Brachys ovata* and *B. aerosa* are too small to support more than one parasitic larva but the mines of *P. ulmella* sometimes contained as many as six pupæ and the size of the mine indicated that only one larva of *P. ulmella* had been present. All of the *Brachys* egg except the shell is consumed by the larva of *C. cinctipennis* and pupation takes place within the shell. In the case of the larva of *P. ulmella*, everything is consumed except the outer skin and the alimentary canal and pupation takes place anywhere within the mine. The eggs of *Brachys* which are normally whitish and semitransparent before hatching become black when parasitized. The larvæ and pupæ of *C. cinctipennis* appear to be very similar to those of other members of the family.

Larva: Length 1.35 mm. Width 0.4 mm. Grublike, whitish, subcylindrical, glabrous, rounded anteriorly, pointed posteriorly, anal segment divided, segmentation indistinct, oral cavity on median ventral surface of head, mandibles almost invisible.

Pupa: Length 1.4 mm. Width 0.5 mm. Naked, shining black. The pupa is anchored to the floor of the mine with its posterior end within the cast skin of the larva. Upon holding the leaf up to the light the pupa is seen to be surrounded by from five to eight dark spots arranged more or less symmetrically. These dots are the ends of excrement like supports or beams which run from the roof to the floor of the mine and which undoubtedly prevent the upper and lower leaf surfaces from caving in on the pupa and probably interfering with development. These supports are also present in the parasitized *Brachys* eggs.

Adult: The following is Ashmead's description of the male:

"Length .04 inch. Head, pleura, sternum, metathorax and abdomen blue; collar, mesothorax and scutellum golden green

strongly punctate. Head emarginate in front and consequently very thin anteroposteriorly. Antennæ brown-black, hairy. Legs brown, trochanters, tips of tibiæ and tarsi pale or whitish. Wings hyaline, fringed with long hairs, forewings with a brown band extending across the stigmal region and another at the apical margin."

FIRST ACCOUNT OF A THERMOTROPISM IN *ANOPHELES PUNCTIPENNIS*, WITH BIONOMIC OBSERVATIONS.

BY WERNER MARCHAND.

Department of Animal Pathology, Rockefeller Institute for Medical Research, Princeton, N. J.

In the fall of 1915, while taking part in a survey of the breeding-places of Anopheline mosquitoes in the neighborhood of Princeton, in coöperation with the local Mosquito Extermination Commission, the writer made certain observations on the mosquitoes encountered. This account is restricted to a few facts which appear to be new or serve to clear up some doubtful point in the life history of the mosquitoes.¹

I. *Bionomics of the Larvæ.*

In the Princeton region, only two species of Anopheles have been recorded, these being *A. quadrimaculatus* and *A. punctipennis*. The latter species is by far the more common, but, since King's experiments (1916),² it cannot be regarded as entirely harmless. It is doubtful, however, whether this species, which has been found to occur as far north as Boston, Mass. (Th. Smith),³ is also in the northern states a regular carrier of malaria.

The larvæ of *A. punctipennis* were kept captive in large numbers and lived best in a flat dish which was left uncovered in order to give free access to the air. In a dish about eight inches in diam-

¹ The writer wishes, on this occasion, to express his thanks for the kind helpfulness through which his work was facilitated by Professor E. G. Conklin and Professor Ulric Dahlgren of Princeton University. Dr. Conklin also had the kindness to revise the English of the MS.

² King, W. V. Experiments on the development of malaria parasites in three American species of Anopheles. *Jour. Exp. Med.*, Vol. 23, pp. 703-716, 1916.

³ Theobald Smith. Notes on the Occurrence of *Anopheles punctipennis* and *Anopheles quadrimaculatus* in the Boston suburbs. *Jour. Bost. Society of Medical Sciences*, Vol. V, pp. 321-324, 1901.

eter, filled to a depth of about one and one-half inches with water from a pond, more than two hundred *Anopheles* larvæ, mostly collected in a half-grown stage, many of them in very young stages, developed into pupæ. The pupæ when formed were taken out with a pipette and transferred to another jar with provisions for the adults to hatch.

In order to rear *Anopheles* larvæ successfully, it is necessary to feed them, and this fact has not been sufficiently emphasized. It was found that certain unicellular surface algæ, the species of which could not be determined, form a very satisfactory food. These algæ developed freely in one of the glass-covered aquaria in the Vivarium of Princeton University. In this aquarium they covered the whole surface of the water in a continuous green sheet, which was wrinkled and folded in places through the excessive development of the algæ. In order to transfer these to the culture dishes it was sufficient to dip the finger into this stratum and then dip it into the *Anopheles*-basin; here the algæ, upon reaching the clear surface of the water, would immediately spread out over the whole surface in the form of a thin, opaque, green layer. The *Anopheles* larvæ would at once start feeding upon these minute algæ, a clear area soon forming around the head and mouthparts of each larva. Before evening, the larvæ had cleared the whole surface of algæ. The procedure was repeated at night in order to provide food for the larvæ to last until the next morning, when again the algæ had been completely devoured. In this way they were fed regularly twice daily. Under ordinary conditions, when *Spirogyra* or other filamentous algæ are given as food (C. A. Smith),¹ many larvæ usually die, because, as a matter of fact, their natural way of feeding is at the surface. Howard, Dyar, and Knab (1912)² suggest that, to provide food the jars in which *Anopheles* larvæ are grown, should be kept uncovered, "in order that the dust from the air may settle continuously upon the water." Undoubtedly, the *Anopheles* larvæ may feed on surface bacteria or protozoa, but in absence of green plants, the contamination of the water often causes death. When surface algæ are given, as in the case here recorded, practically no larvæ are lost, because these algæ produce oxygen

¹ Cora A. Smith. The Development of *Anopheles punctipennis* Say. *Psyche*, Vol. XXI, p. 1.

² Howard, Dyar, and Knab. The Mosquitoes of North and Central America and the West Indies. Vol. I, 1912.

in abundance, and the water does not have to be renewed at all. The quantity of algæ devoured by the larvæ was quite considerable. Lack of attention to this detail may perhaps explain the frequent failures in rearing *Anopheles* larvæ.¹ On the other hand, the use of surface algæ as food may serve to determine with exactness the quantity of food consumed by a single larva, since the algæ, under carefully chosen conditions, cover the surface quite evenly in a layer of measurable thickness, and therefore the quantity of algæ present on a surface of given dimensions and consumed in a given time may be estimated or calculated, and, divided by the number of larvæ feeding on this surface, would give the quantity consumed by a single larva. However, as the season was advanced, and the larvæ were transforming into pupæ, this experiment was not carried out.

The larvæ showed in a remarkable degree the characteristic instinct spoken of by Zetek,² to drop to the bottom when a shadow passed over their heads. When the writer came near them, in the morning, after they had been completely undisturbed for many hours, the phenomenon was particularly striking. The larvæ would drop almost simultaneously and then would remain at the bottom for several minutes.

In this connection, it may be noted that Graham has stated that, in the Sudan, microscopic fresh-water algæ form the principal food of *Anopheles*, a fact not unimportant for their control, since it may be that the mosquitoes may be kept in check by methods aiming at a destruction of the algæ.³

II. *Bionomics of the Adult Stage.*

The resting position of *Anopheles* has often been used as a characteristic to distinguish the malarial mosquito from other species, the *Anopheles* holding the body, as a rule, at a certain angle to the surface on which they are resting. This angle is, in *A. punctipennis*, usually about 45°; Nuttall and Shipley's illustration as reproduced

¹ W. M. Graham (A study of Mosquito larvæ, Jour. Ent. Research, Vol. I, 1910) has stated correctly that failure to rear the larvæ is not to be wondered at when it is recognized that mosquito larvæ require a constant supply of special food, consisting usually of living fresh-water algæ. In the absence of algæ the larvæ become cannibalistic and destroy one another.

² Zetek, James. Behavior of *Anopheles albimanus* Wiedemann and *tarsimaculatus* Goeldi. Ann. Ent. Soc. of America, VIII, 1915, p. 221 ff.

³ Graham, loc. cit.; these algæ were not surface algæ but were suspended in the water; as stated, however, the *Anopheles* larva is mainly a surface feeder.

by J. B. Smith (Mosquito-control exhibit, N. J. State Museum),¹ in which it is represented to form a right angle with the surface, is an extreme case and not quite typical. It seems, however, that mosquitoes which rest for many hours in the same place, assume a more oblique position than do these which have just alighted. These characteristics apply only to *Anopheles punctipennis*, not to *A. quadrimaculatus*. Hibernating females of the latter species were observed beyond doubt in a resting position in which the body was held about parallel to the resting surface, as illustrated in the accompanying drawing from nature (Fig. 1). Hence, they can be easily mistaken for *Culex* if only the resting position is taken as a criterion.²



Fig. 1. Resting position of hibernating female of *Anopheles quadrimaculatus*.

Sketch-drawing from Life.

Concerning the biting position of *Anopheles*, Nuttall and Shipley's illustration (J. B. Smith, N. J. State Museum exhibit) is not entirely correct (Washburn),³ and H. P. Johnson⁴ is in error in assuming that the mosquito must necessarily bite with proboscis inserted at a right angle. As a matter of fact, *A. punctipennis* will insert the proboscis usually at an oblique angle, the mosquito biting in a position much like the resting position, and the line of the proboscis forming the continuation of the longitudinal axis of the body. This is evidently of advantage for the sucking mechanism.

III. *The Biting Instinct due to a Thermotropic Reaction.*

Observations were also made on the biting instinct, which as it seems, is determined mainly by thermotropism. Patton and Cragg (1913) have reported⁵ that Howlett observed that females of

¹ Nuttall and Shipley. The structure and biology of *Anopheles maculipennis*, Jour. of Hygiene, 1901.

² Howard (loc. cit. p. 205) has recorded the same fact for *A. quadrimaculatus* hibernating in barns in southern Idaho.

³ Washburn, F. L. Economic Entomology at the World's Fair. Science N. S., Vol. XX, No. 518, 1904, and "The Biting position of *Anopheles*." Science, N. S., Vol. XXI, p. 228, 1905.

⁴ J. B. Smith. How does *Anopheles* bite? Science, N. S., Vol. XXI, pp. 71-72, 1905.

⁵ Patton and Cragg. Textbook of Medical Entomology. London, Madras and Calcutta, 1913.

Stegomyia scutellaris were attracted by the hot air radiating from a test tube filled with hot water. On the other hand, shed blood and sweat did not attract the ♀♀ of this species and *Culex fatigans* any more than water. Howlett's experiments were not known to me at the time when these observations were made, and since they were obtained independently of other observers, and the phenomenon was not known to apply to Anopheles, I may briefly report on them here, especially as data on thermotropism in insects are very scanty. The Anopheles which were kept in lamp chimneys for other purposes, were fed on apple jelly which was spread out on a glass plate. In order to prevent the mosquitoes soiling their legs and wings, the jelly was covered with filter paper. In the intention of providing a food as natural as possible, I heated the apple jelly on the glass plate, assuming that it would then be taken more readily. This was in fact the case. The mosquitoes came quickly to the filter paper and would bite through it as if it were human

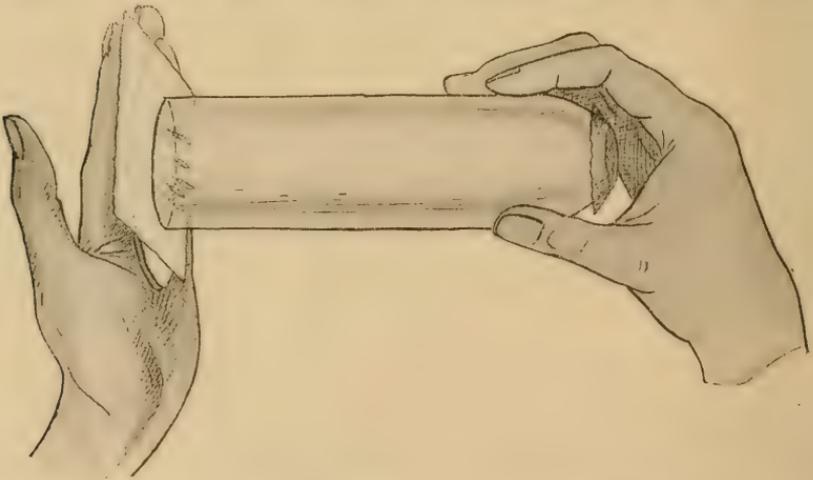


Fig. 2. Arrangement used in demonstrating the thermotropism of mosquitoes.

skin. The question suggested itself whether they were attracted by the odor of the jelly or, possibly, by the heat radiating from it. Being curious whether the mosquitoes would be attracted also by heat alone, I substituted for the glass plate which was covered with jelly, a clean one which was heated to a degree fairly above human body temperature but, of course, not excessive, and covered with

filter paper in the same way as before, in order to provide a foothold for the insects. The mosquitoes were attracted under these conditions in the same way as if food had been present, each one attacking the surface of the filter paper which covered the glass plate, and all bending their proboscis in repeated efforts to pierce the surface. The number of mosquitoes used was about five or six at a time. The arrangement was that given in the diagram (Fig. 2). If several mosquitoes are used in biting experiments, there will usually be some individuals which will show no inclination to bite, but the percentage of individuals not attracted by the heated glass plate, was about the same, and not greater than in the biting experiments. The males showed the same tropism as the females but much less strongly. As soon as the glass plate had cooled off, the mosquitoes became indifferent. However, the experiment could be repeated with the same mosquitoes as also with different sets and always with the same results.

These observations, taken together with those made by Howlett, indicate that this thermotropic reaction is a very important factor to be considered in the analysis of the bloodsucking instinct.

I have, since, tried to confirm these facts by observations on other species of mosquitoes, but so far have used only the hibernating females of *Aedes sylvestris*. These, however, did not show even a trace of the thermotropic reaction observed in *A. punctipennis*. On the other hand they also consistently refused to bite, though various food other than blood was readily accepted. Females of *Anopheles* are known to bite occasionally in winter, and therefore, usually hibernate in stables where blood can be obtained (Grassi and others; see Howard, Dyar and Knab),¹ while *Aedes* which hibernates in cellars, seems not to bite at all during the winter even if brought into a heated room. The absence of thermotropism would, therefore, in this case, be only an adaptation to the conditions of hibernation, during which no blood food is taken, and it is perfectly possible, that *Aedes sylvestris* will be found thermotropic during the "biting season" unless, in this genus, other tropisms are involved.

¹ Loc. cit. p. 206-209.

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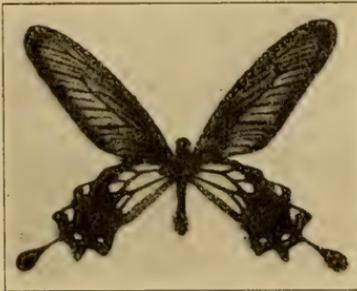
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